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CONTRIBUTIONS OF MEDICAL RESEARCH IN CHEMICAL WARFARE TO MEDICINE[1]

By Major OSCAR BODANSKY, M.C.

MEDICAL DIVISION, CHEMICAL WARFARE SERVICE, EDGEWOOD ARSENAL

IN the war which has just ended only certain aspects of chemical warfare such as smokes, flame throwers, white phosphorus, incendiaries and fire bombs were employed. The toxic gases remained unused. Yet the potential employment of these substances was a constant threat throughout the entire course of the war. We now have abundant evidence that our enemies were prepared both offensively and defensively for the vigorous use of these agents. Their research institutes investigated the toxic properties of the agents which had been employed in World War I as well as of other agents which were subsequently developed. Our enemies studied in great detail the methods by means of which these agents could best be dispersed, and the relation of their effectiveness to varying conditions of terrain and weather; they developed protective devices, first-aid measures and methods of treatment.

But this country and its allies were at work even more intensively in these various aspects of chemical warfare. England, which was in a particularly vulnerable position because of her proximity to Germany, had maintained an active research group after World War I. When political events indicated the imminence of a second world war, research activities were intensified.

It is not the purpose of the present paper to describe the development of chemical warfare research in this and the Allied countries, but rather to indicate the contributions of such research to medicine. However, it is relevant in this connection to describe briefly the vast array of scientific forces which were marshalled in this country to study the toxic and

[1] Read on October 9, 1945, at the New York Academy of Medicine Graduate Fortnight, Beth Israel Hospital Clinic.

physiological properties of chemical warfare agents, to develop methods of protection against their use and methods of treatment of casualties. Almost all these projects were classified during the war as secret or confidential; the public and indeed many scientific workers were not aware of how thorough and extensive were the preparations for the possible use of chemical warfare.

On June 28, 1941, a Presidential executive order established the Office of Scientific Research and Development under Dr. Vannevar Bush. There were two main subdivisions of this office: the already existent National Defense Research Committee (NDRC) and a new Committee on Medical Research (CMR). In March, 1941, certain sections of the NDRC had been assigned the task of developing and testing new toxic agents, determining the types of injury which they produced and the mechanisms of their actions. In the fall of that year, the Committee on Treatment of Gas Casualties was established under the Committee on Medical Research. In both divisions, contracts to study these problems were given to biochemists, physiologists, pathologists and clinicians at many of our leading medical schools and research institutes.

Simultaneously with the creation of civilian organizations to investigate the medical aspects of chemical warfare, there occurred marked developments in the Army research facilities. In the interval between the two world wars, the medical research group at Edgewood Arsenal was very small and had extremely limited laboratory facilities. It was constantly subjected to the vicissitudes of changing policy. As the European political situation increased in tenseness, the Surgeon General of the Army recognized the need for investigations leading towards definitive treatment of gas casualties, and in 1936 a Medical Department unit was created for this purpose at Edgewood Arsenal. When the possibility arose that we might become involved in the European conflict, activities intensified; the demands for research and for instruction of medical officers increased. Towards the end of 1942 men of known investigative ability were called into the Army for assignment at Edgewood Arsenal and other chemical warfare installations. Plans were made for the building of a large up-to-date, well-equipped laboratory, and in June, 1943, the Medical Division of the Chemical Warfare Service was organized. By an agreement between the Surgeon General of the Army and the Chief, Chemical Warfare Service, one of the ultimate functions of the Medical Division was to recommend methods of protection and treatment of the soldier exposed to chemical warfare agents. In 1944, several months after the new laboratory had been in operation, research activities were at their peak, with about 150 officers and civilians directly engaged in investigation. To supplement its work, especially in those phases where clinical facilities were necessary, the Medical Division contracted directly with research groups in various universities.

Although the prime purpose of the research organizations mentioned above was to study the toxicology and mechanism of action of chemical warfare agents and methods of preventing and treating gas casualties, it was inevitable that there issue from this vast amount of research information both of fundamental and of direct clinical value to medicine. In the present paper it will be shown, in the case of each agent, how this information arose from the necessity of solving certain pressing problems in the therapy of gas casualties. It would not be appropriate at this time to describe in any detail the results of these investigations, since to do so would be to anticipate publication by the various investigators who carried out this work. However, it is possible to indicate the scope of these investigations, to refer to work which has already been published, and to describe in somewhat greater detail that in which the author has participated.

Before beginning the discussion of the studies on the various chemical warfare agents, it is well to emphasize that effective chemical warfare agents appear to possess the common characteristic that their interactions with tissue components are either completely or highly irreversible, at least by the standards of biochemical reactions to which we have been hitherto accustomed. Thus the problem of rational therapy against injury by chemical warfare agents is inherently a very difficult one and involves the general task of investigating more fully the question of the reversibility of cellular biochemical reactions.

Mustard had proven a very effective agent during World War I, being definitely responsible for almost 40 per cent. of the total gas casualties. The prevention or treatment of casualties due to this agent and to related substances, the nitrogen mustards, which had been developed since World War I, became a problem of prime importance when war threatened. There were two aspects of the action of these agents which demanded consideration, the vesicant and systemic effects.

It will be readily realized that the problem of vesication is one of considerable interest to dermatologists, and indeed to clinicians generally. Here was a group of chemical compounds which in very small amounts reacted with some constituent of the skin and set in motion an apparently irreversible train of events resulting in the progressive development of liquefaction necrosis in the cells of the lower layers

of the epidermis, the exudation of tissue fluid and the final formation of intraepidermal vesicles which might be of considerable size. The approach to this problem was fundamental. The kinetics of the interaction of the mustards with various amino acids and proteins, the action of the mustards on various enzyme systems both *in vitro* and *in vivo,* the mechanism of skin penetration and the effect on cell structures were all studied in considerable detail. Although in the treatment of vesication due to the mustards, success was limited, similar studies, as we shall presently see, provided a basis for the rational treatment of vesication due to lewisite. But in both instances, the studies referred to have produced a considerable amount of basic biochemical knowledge which will undoubtedly find its application in the future.

Although the systemic effects of the mustards had not been neglected, the Bari incident focussed considerable attention on this aspect. On December 2, 1943, German planes raided the harbor of Bari and several ships were sunk. One ship containing a considerable load of mustard bombs exploded; the floating mustard and the oil from a broken pipe line formed a mixture through which survivors were forced to swim. In addition to the skin, eye and respiratory tract injuries usually noted, systemic effects appeared to be especially marked. Many of the individuals appeared to be in shock, but did not respond to the usual shock therapy. The question arose as to whether the systemic effects noted were specific or were basically the same as those produced by thermal or traumatic injury. Considerable animal experimentation was initiated to study electrolyte and water equilibria, electrophoretic serum protein patterns, and tissue phosphorylation reactions not only in mustard poisoning but in thermal and traumatic injury as well.

The eye is especially vulnerable to the action of mustard vapor; the injuries range from a mild conjunctivitis to severe corneal involvement, depending upon the concentration of the vapor and duration of exposure. The earliest attempts at therapy were concerned with finding some drug which might neutralize the combination of mustard with components of the eye tissues. These attempts entailed the laborious and painstaking collection of new data on the effect of different compounds instilled into the normal eye. When penicillin was not yet available to the general medical profession, its effect in preventing secondary infections in mustard-gassed eyes was already being established. As will be noted later, in the eye as in the case of the skin, fundamental studies provided a basis for the rational treatment of injuries due to lewisite.

One of the most marked actions of the mustards is the production of leukopenia. In experimental animals, the administration of these compounds causes involution of the lymph nodes and aplasia of the bone marrow. These observations stimulated the use of some of the mustard compounds in the treatment of malignant lymphomatous diseases. Work along these lines is now in progress at several universities. It is, of course, too early to make any statements concerning the efficacy of any procedures so far carried out.

Phosgene also proved its worth as an effective chemical warfare agent during World War I. The lethal action of this gas is due to increased permeability of alveolar membranes and the production of pulmonary edema, a process which, once set into motion, is difficultly, if at all, reversible. The mechanism of this production claimed considerable attention, therefore, at the outset of the present war. The value of oxygen administration during the phase of the development of pulmonary edema was explored. As a consequence of experimental work indicating that oxygen inhalation was of value in decreasing mortality, apparatus was developed which incorporated the full-face Army gas mask facepiece and expiratory valve and an oxygen hose line which permitted twenty men to inhale oxygen simultaneously through a demand system. This apparatus enabled investigators to employ large numbers of subjects in order to answer a question which has been the subject of considerable debate, namely, whether 100 per cent. oxygen administered for 24 to 48 hours is toxic.

This work which has recently been published[2] showed that 100 per cent. oxygen administered continuously for 24 hours produced substernal distress in 82 per cent. of the cases. Signs of nose and throat irritation were common, and vital capacity was decreased. Inhalation of 100 per cent. oxygen at high altitudes (low oxygen tension) or inhalation of 50 per cent. oxygen at ordinary atmospheric pressures did not result in any symptoms. It was concluded that administration of 100 per cent. oxygen for short periods of time probably is safe in all patients, but that if it is necessary to give oxygen for longer than 12 hours, the oxygen content should be reduced to 60 per cent. unless this is insufficient to saturate the arterial blood. If 100 per cent. oxygen must be given, careful attention should be paid to the appearance of symptoms due to the toxicity of oxygen.

One of the dramatic accomplishments in chemical warfare therapy was the British development of a compound which specifically counteracted the injurious effects of lewisite, both systemically and in local lesions of the eye and skin. We may not at present

[2] Comroe *et al., Jour. Am. Med. Asn.,* 128: 710, 1945.

reveal the formula of this compound, which has been designated as BAL, or "British anti-lewisite."

The mechanism of the action of BAL was based on a reversal of the interaction of the arsenic in lewisite with certain tissue components. Several investigators readily appreciated at this point that the action of BAL might be directly applicable to the treatment of heavy metal poisoning in general, and active study along these lines was inaugurated in several institutions.

The most immediate and gratifying results were obtained in the treatment of toxic reactions resulting from the administration of arsenic-containing compounds, particularly mapharsen, in the course of antisyphilitic treatment. Details concerning the use of BAL in this connection may be given here, since this information has been published in an open War Department Technical Bulletin (No. 104, 12 October, 1944). BAL is used as a solution in oil, packaged in sterile ampoules containing 500 mg BAL in 5 cc and is for intramuscular injection only. The recommended dose is 0.025 cc per kg of body weight, repeated 4 times at 4 hourly intervals during the first day, and once daily for the following 6 days. Minor toxic reactions at this dosage of BAL occur in about 1 per cent. of injections and may consist of nausea, generalized aches and pains and a burning sensation in the mouth and eyes. The symptoms are transitory and disappear in 30 to 60 minutes. This treatment has given highly satisfactory results in patients with arsenical dermatitis and toxic arsenical encephalitis. Work in selected institutions is continuing, and negotiations are under way with the British for the release of BAL for general use by the medical profession.

At the beginning of this war, the British chemical warfare investigators began to study the physiological properties of a group of compounds which had been described by German chemists in the open literature in 1932. The British investigators found that these agents possessed an anticholinesterase action. In 1943, the Medical Division at Edgewood Arsenal became interested in this group of compounds, and comprehensive programs were initiated to study fully their toxicity and the mechanism of action and, if possible, to devise therapy against their injurious effects. One of these compounds appeared at first to be promising as a chemical warfare agent and, although it did not finally qualify in this respect, studies on the mechanism of its action revealed very interesting anticholinesterase properties.

In contrast to the action of such substances as prostigmine and physostigmine, this compound decreased the activity of cholinesterases in tissues and in blood in an apparently irreversible manner. It was also found that when animals or men were exposed to or injected with this substance, the cholinesterase activity of the blood and of tissues was decreased for a considerable length of time. For example, a number of men were exposed to very low concentrations of this compound. Except for a marked miosis which occurred in all these individuals, symptoms were minimal. There was a feeling of tightness and constriction in the chest in most of the men which persisted till the next day. Rhinorrhea, salivation, diarrhea each occurred in a few of the men. However, the most striking change observed was biochemical in nature; there was a marked decrease in the serum cholinesterase activity to about only 1 to 5 per cent. of the pre-exposure value. This degree of inhibition of the activity of a body enzyme is, so far as the author is aware, unprecedented. The rate of return to normal serum cholinesterase activity was very slow, being about 30 per cent. of normal in 4 days, 50 per cent. of normal in 8 days and about 70 per cent. of normal in 15 days.

Because of this prolonged anticholinesterase effect, it was decided to investigate the extent to which this compound could be used in clinical conditions in which there may be a disturbance in acetylcholine-cholinesterase relationship. It has been postulated that in myasthenia gravis there is a deficiency of acetylcholine at the myoneural junctions. Prostigmine is used in this condition on the basis that it inhibits cholinesterase activity at the myoneural junctions and thereby permits the accumulation of acetylcholine with a resultant improvement in muscle strength. However, it is necessary to give prostigmine at rather frequent intervals. It was believed that the compound to which we have referred might produce a more prolonged inhibition of the enzyme at the myoneural junctions and therefore simplify therapy considerably. Programs to investigate the efficacy of this chemical warfare agent in the therapy of myasthenia gravis have been inaugurated in several institutions. The use in glaucoma has also been investigated and is under further consideration.

The extremely toxic properties of hydrocyanic acid have been known for centuries. During the last war there was considerable difference of opinion as to whether hydrocyanic acid would constitute an efficient war gas. The French used this gas on one occasion with what they believed to be a high degree of success. With changes in types of munition and dispersal since the last war, hydrocyanic acid came to the fore again as a chemical warfare agent.

The problem of therapy therefore became an important one. In 1888 Pedigo first showed that amyl nitrite inhalation was effective in the treatment of dogs subcutaneously injected with cyanide. About 1930, several groups of investigators, notably Chen

and his collaborators, showed that the immediate intravenous injection of a combination of sodium nitrite and sodium thiosulphate was effective in saving animals subcutaneously injected with sodium cyanide. Consideration of Chen's experiments shows that his advocated therapy would be more effective in oral poisoning where the poison is absorbed gradually than in that due to inhalation of cyanide where absorption occurs instantaneously and the maximal effect on the tissue oxidative systems has occurred by the time therapy is instituted. It was necessary for us to determine the extent to which such therapy was effective in inhalation poisoning.

The mechanism underlying the use of nitrites in cyanide poisoning is the formation of methemoglobin. There is considerable *in vitro* evidence to indicate that this pigment competes with the respiratory pigment, ferricytochromeoxidase, for cyanide ion. The question arose as to whether the deliberate production of methemoglobin in the blood might not constitute an effective prophylactic measure against cyanide and thus be employed, in addition to the gas mask, to safeguard the soldier. In this connection, it was necessary to investigate substances which could readily produce methemoglobinemia without any physiological effects other than that due to the methemoglobinemia itself. A compound which had previously been reported in the literature appeared to fulfil these requirements. Methemoglobinemia was induced in animals as well as in a considerable number of men. Various aspects of the induced methemoglobinemia were then studied: the blood chemistry, the oxygen dissociation characteristics of the blood, the work capacity, effect on dark adaptation and the effects on hematopoietic, renal and liver functions. Embarrassing and lethal levels of methemoglobinemia were ascertained in animals. Methods of treatment of various degrees of methemoglobinemia were investigated.

The application of these studies to clinical medicine is apparent. Methemoglobinemia may result from the administration of certain drugs or from the absorption of toxic materials used in industry. Cases of familial idiopathic methemoglobinemia have also been reported in the literature. The information which has been obtained in the course of the studies referred to above will be of considerable aid in the diagnosis, prognosis and treatment of such conditions.

The studies on cyanides have had other interesting implications. In 1918, Loevenhart, in the course of studying the property of sodium cyanide as a respiratory stimulant, observed that the administration of cyanide to a schizophrenic patient resulted in a brief return towards normal mental processes. So far as the author is aware, this observation did not find any subsequent application. For a number of years physiologists and biochemists have been studying the effect of cyanide on tissue metabolic reactions. It has been possible for us at the Medical Division to extend and elaborate these studies. Since the lethal action of cyanide depends upon a central nervous system effect, the metabolic reactions in brain tissue have claimed special attention. With these and studies on toxicity of cyanides as a background, attention was redirected to the possible use of cyanides in the treatment of certain types of schizophrenia. A program is now in progress at one of the neuropsychiatric centers in this country to study, by means of encephalographic and other newer techniques, the effect of cyanide on brain activity and, if feasible, to apply these results to the treatment of certain selected cases of schizophrenia.

In this paper it has been possible to sketch only briefly the contributions which research in chemical warfare has made to medicine. There have been other contributions which, for lack of time, it has not been possible to describe or mention. It is interesting to note that the story of these contributions is the story of fundamental research everywhere. The prime purpose of the research workers in chemical warfare was to determine the toxicity of certain chemical warfare agents and to devise therapy against their use. But, wherever possible, the approach used was fundamental, not empirical. It did not consist of haphazard, disconnected attempts to find substances which somehow might prove useful in therapy. Its methods were to initiate systematic investigations into the mechanisms of action of the chemical warfare agents, and to build therapeutic procedures upon the results of such investigations. It was this type of approach which, in spite of the urgencies of war, yielded practical returns in our treatment of gas casualties and contributed substantially to fundamental and clinical progress in medicine.

OBITUARY

ROBERT H. GODDARD

IN the passing on August 10, 1945, of Dr. Robert H. Goddard, American science and engineering lost one of its greatest pioneers—the creator of the modern science of jet propulsion and rocketry.

His investigations had covered almost every essential principle involved in both the theory and practice of jet propulsion, particularly as applied to high-power rockets. His work was mainly responsible for the immense progress of the subject in the last three

decades, which has exceeded in importance the results previously attained in several centuries of early development.

His research and his inventive mind produced the first liquid-fuel rocket, the first smokeless-powder rocket, the first practical automatic steering device for rockets and innumerable other devices. He was one of the first to develop a general theory of rocket action, including the important "optimum velocity" principle, and to prove experimentally the efficiency of rocket propulsion in a vacuum.

Even more impressive than Dr. Goddard's technical skill, insight and ingenuity was his extraordinary perseverance, patience and courage. He carried on many of his investigations in the teeth of public skepticism and indifference, with limited financial resources and in spite of heartbreaking technical difficulties—a combination of obstacles which might have baffled and disheartened a less stout-hearted pioneer. Almost single-handed, Dr. Goddard developed rocketry from a vague dream to one of the most significant branches of modern engineering.

Goddard was born in Worcester, Mass., on October 5, 1882. His early schooling was obtained at Boston, where he lived with his family until he was sixteen. His college work was taken at Worcester, where he was graduated from the Worcester Polytechnic Institute in 1908.

Upon graduation, he obtained a position at Worcester Polytechnic Institute as an instructor in physics. He continued to be connected with the academic world until 1943, part of the time on leaves of absence. His teaching career was conventional, rising in the usual steps from instructor to assistant professor and finally to full professor at Clark University. During a small part of this period, in the 1912–1913 season, he served as research fellow at Princeton University. The rest of his academic career was passed in Worcester.

It was during his brief period at Princeton in 1912 that he made the initial computations which later were to form the basis of his first publication in the new field of rockets and jet propulsion: "A Method of Reaching Extreme Altitudes," which was issued seven years later, in 1919, by the Smithsonian Institution. In this Princeton period, when he was about thirty, the great excitement of discovery first began to come upon him, for his calculations clearly indicated that only a little fuel, relatively, would be required to lift a payload to really great heights by rocket power, provided the rocket were so constructed as to make use of the fuel effectively.

Upon returning to Clark, in 1914, he began to experiment, beginning with ship rockets, and continuing with rockets of various types manufactured by himself. By 1916 he had reached the limit of what he could do on his own resources. Inexperienced though he was in the ways of money-raising for scientific research, his earnestness and enthusiasm won respect and attention. When he presented his ideas on paper to the Smithsonian that year he promptly received a letter from Dr. Charles D. Walcott, then secretary of the institution, commending him on the report and inquiring how much money would be needed.

Goddard guessed it might ultimately require $10,000, but cautiously asked for $5,000. Between that day in 1916 and the appearance of his first paper in 1919, the experimental work actually required a total of $11,000, the whole sum of which was made available by the Smithsonian. This was the investment that launched modern rocketry and jet propulsion.

The rest of Goddard's published achievements are told, factually, in his Smithsonian report of 1919, and a subsequent paper published by the Smithsonian in 1936, entitled, "Liquid-Propellant Rocket Development." What is not disclosed in these reports—what can never be told adequately—is the labor, persistence, thought and heartbreak that went into these accomplishments, through which Goddard fathered so much of the research and development which led to the great expansion of jet propulsion in the Second World War.

Most of the early work which led to the publication of the 1919 report was done at or near Worcester. After the publication of that report, which dealt principally with the possibilities of powder or "dry fuel" rockets, he turned to research in liquid fuel rocket motors. On March 16, 1926, he shot the first liquid fuel rocket ever constructed, a strange-looking contrivance about ten feet tall, which was the ancestor of all the liquid fuel rockets constructed since, including, of course, the German V-2 rockets.

In 1929 his work attracted the attention of Colonel Charles A. Lindbergh, who communicated his interest to the late Daniel Guggenheim. From that time until his death, a great part of Goddard's research was underwritten by Daniel Guggenheim and later by the Daniel and Florence Guggenheim Foundation. This support made it possible to establish quarters on Mescalero Ranch, near Roswell, New Mexico, where experimental conditions were excellent. It was there that Goddard made the rapid strides in liquid fuel rocket development disclosed in his 1936 Smithsonian report.

After the entry of the United States into the first World War in 1917, Goddard volunteered his services, and undertook the task of exploring the military possibilities of rockets. He succeeded in developing a trajectory rocket which fired intermittently, the charges being injected into the combustion chamber by a

method similar to that of the repeating rifle. He also developed several types of projectile rockets intended to be fired at tanks or other military objectives, from a launching tube held in the hands and steadied by two short legs, a device similar in many respects to the "bazooka" of World War II.

These weapons were demonstrated at the Aberdeen Proving Grounds on November 10, 1918, before representatives of the Signal Corps, the Air Corps, the Army Ordnance and others. The demonstrations went off quite successfully, but the Armistice next day put an end to the war and also to the experiments.

In the Second World War Goddard likewise offered his services, and was engaged in work on liquid fuel rocket research for the Navy at Annapolis throughout the conflict.

Goddard concluded his last report, in 1936, with these words: "The next step in the development of the liquid-propellant rocket is the reduction of weight to a minimum. Some progress along this line has already been made."

Part of this progress consisted of the development of ingenious, light-weight, simple fuel pumps for injecting the propellants rapidly into the liquid-fuel rocket motor. The physicist had expected to return to New Mexico as soon as possible after the war, to continue his work on high altitude rockets, and planned to set some altitude records which would have been spectacular indeed. His death, at the age of 62, brought this program to an untimely end. Nevertheless, Goddard lived to see the dream of his youth become reality. Jet propulsion, for the uses of war at least, matured in his lifetime from a fantastic notion into a billion-dollar industry. It gave promise, too, of achieving the objectives of peacetime research for which he had spent a lifetime of thought and effort.

Dr. Goddard had been a member of the American Rocket Society for many years, and a few months before his death was elected to the society's Board of Directors. He was universally beloved and respected, and especially so by his associates in research on rockets and jet propulsion. The Board of Directors of the American Rocket Society paid tribute to him in these words:

> The lifework of Dr. Goddard, both as a scientist and a man, will always remain a brilliant inspiration to all of those who are privileged to carry on his endeavors, and to every other bold explorer on the new frontiers of science. In time to come, his name will be set among the foremost of American technical pioneers.

G. EDWARD PENDRAY,
Secretary, American Rocket Society

RECENT DEATHS

DR. EUGENE COOK BINGHAM, professor of chemistry at Lafayette College, died on November 6 at the age of fifty-six years.

DR. RODNEY B. HARVEY, professor and head of the Section of Plant Physiology of the University of Minnesota, died on November 4 at the age of fifty-five years.

DR. RALPH HENRY SMITH, professor of entomology and entomologist in the Agricultural Experiment Station of the University of California at Los Angeles, died on September 22 at the age of fifty-seven years.

DR. CALVIN S. BROWN, professor of Romance languages at the University of Mississippi, well known for his work in geology and in archeology, died on September 10 at the age of seventy-nine years.

SCIENTIFIC EVENTS

THE SUMMER MEETING OF THE AMERICAN MATHEMATICAL SOCIETY

THE fifty-first summer meeting of the American Mathematical Society was held at the New Jersey College for Women of Rutgers University, New Brunswick, on September 15, 16 and 17. The Institute of Mathematical Statistics met on September 16. In accordance with the restrictions on conventions by the Office of Defense Transportation, the society has held no previous meetings in the east or midwest since the annual meeting on November 24–25, 1944, in Chicago. The attendance was about four hundred, including three hundred and twenty members of the society.

Three addresses were given: "Some New Viewpoints in Differential Geometry in the Large," by Professor S. S. Chern, of the National Tsing Hua University and the Institute for Advanced Study; "Topological Methods in Abstract Algebra," by Professor Samuel Eilenberg, of the University of Michigan; "Some Aspects of Ergodic Theory," by Professor Witold Hurewicz, of the University of North Carolina.

On Sunday afternoon a symposium was held on "Recent Developments in Numerical Methods," consisting of three addresses: "Interpolation, Smoothing and Curve Fitting," by Professor I. J. Schoenberg, of the University of Pennsylvania; "Laurent Expansions of Algebraic Functions," by Professor Hans Rademacher, of the University of Pennsylvania, and

"Numerical Solutions of Integral Equations," by Professor A. T. Lonseth, of Northwestern University.

One hundred and thirty-one research papers were presented at this meeting, thirty-five in person and ninety-six by title.

T. R. HOLLCROFT,
Associate Secretary

RESEARCH INSTITUTIONS OF BIOLOGY

THE following statement has been submitted by the Committee on the Promotion of Research of the Michigan Academy of Science, Arts and Letters to the Subcommittee on War Mobilization of the Senate Military Affairs Committee, of which Dr. Lee R. Dice is chairman, which is currently holding hearings on proposals to increase research in the United States:

We earnestly urge the establishment of research institutes of biology in each state and territory of the United States and their generous support jointly by both the federal and state government. These biological research institutes should be dedicated to the discovery of the fundamental laws of biology and the application of biological knowledge to human affairs. Among the problems to be investigated should be included the causes of human diseases and mental disorders, the factors that determine human aptitudes and special abilities, the effects of different types of environments on the human organism, and the adjustment of human societies and cultures to the conditions and resources of their habitats. This kind of research can best be carried out in the individual states rather than concentrated in a single federal institution. Research in human biology surely deserves adequate support by the nation at least as much as and in addition to research in agriculture, in physical science and in engineering.

THE MAGNUSON BILL

THE executive committee of the Pacific Division, American Association for the Advancement of Science, at its meeting in San Francisco on October 19, voted unanimous approval of the following letter, which was written in the first instance by Professor Howard S. Reed to Senator Sheridan Downey of California:

Dear Mr. Senator:

In my capacity as an officer of the Pacific Division of the American Association for the Advancement of Science, I am writing briefly concerning the bills before the Congress regarding national support of scientific research and development.

I have recently been studying the text of Senate Bills 1297, 1285, 1248 and 828. The idea underlying the proposals of the four bills is something new and will undoubtedly provoke an unfavorable reaction on the part of some people just because it is new and venturesome. I do not feel that way about it. I find that these bills recognize the fact that *all* the people should support and promote research in science and the useful arts. Hitherto, support of these activities has come from relatively few public-spirited men and women. In a general way, I favor the proposals outlined in a bill introduced by Mr. Magnuson (Senate Bill No. 1285). The following are my reasons for endorsing this rather than the other proposals:

(1) The proposed National Research Foundation is authorized to develop and promote a broad program and to initiate and support basic scientific research.

(2) The Foundation is authorized to grant scholarships and fellowships. (This is undoubtedly one of the best ways to train promising young men and women.)

(3) The Board of Directors would be free to promote the purposes of the Foundation without the political or semi-political consideration.

(4) The Division of Publications and Scientific Collaboration which could make available to the public scientific information is extremely important, and I speak from experience when I say that privately operating scientific periodicals are fighting desperately for life.

For the first five years the Board of Research and Development could utilize existing laboratories. No greater mistake could be made than to spend large sums at present in the construction of Federal laboratories. It would be much better to make grants of funds to private industrial laboratories or educational institutions under the supervision of the Board of Directors. It will take nearly five years for the board to prepare an adequate program for research. In its essence, men and their intellects are the important things in research rather than lofty buildings. I am not in favor of having the research funds spent in the existing laboratories of the Federal Government because I do not believe that there are now men in those laboratories who are capable of directing basic scientific researches, except in a few cases.

Thanking you for your consideration, I am

Very respectfully yours,

H. S. REED, *Chairman of the Executive Committee, Pacific Division of the American Association for the Advancement of Science.*

The executive committee of the Pacific Division, in endorsing Professor Reed's letter, instructed the secretary to send copies to all members of the Senate and House Committees on Military Affairs, and to send a copy to the editors of SCIENCE.

FEDERAL SUPPORT OF SCIENTIFIC RESEARCH

THE Board of Permanent Officers of the Sheffield Scientific School of Yale University, at a meeting on October 8, 1945, unanimously approved the report of a committee appointed to formulate policy as to federal support of scientific research.

This report recommends the incorporation of four general principles in any legislation concerned with the problem. These are as follows:

First, there should be complete freedom of research, both as to choice of problems and methods of attacking them, on the part of individuals and institutions. No hampering restrictions of any kind should be attached to grants of funds nor should there be attempts by any supervisory agency to regiment scientists or to control the direction of their research. Voluntary cooperation is to be encouraged, and ample support should be given investigators whose studies do not fit into any preconceived program.

Second, the body responsible for the administration of federal support should be completely free from political control and should select its own executive officer. Men chosen for this task should be of the highest scientific reputation and enjoy the confidence of scientists generally. It is desirable that the National Academy of Sciences, which was established to advise the government on scientific matters, should present in nomination a panel of names from which the members of the administrative body would be appointed.

Third, provision should be made for the support of the most fundamental and theoretical scientific investigations, most of which have no obvious practical application. Popular interest and support will naturally center on problems which promise immediately useful returns, but great care should be taken that fundamental problems, always the ultimate source of knowledge upon which applications must be based, are not neglected.

Fourth, since the almost complete cessation of education in science during the war has resulted in a serious deficit in trained scientific personnel in this country, it is important to increase substantially the number of persons receiving such training. This can be done by establishing, through federal funds, a series of undergraduate scholarships, graduate fellowships, and post-doctoral fellowships in the sciences. Compulsory enrollment in a National Science Reserve should not be a stipulation for such support.

FELLOWSHIPS IN THE MEDICAL SCIENCES OF THE NATIONAL RESEARCH COUNCIL

FELLOWSHIPS in the medical sciences, similar to those which have been administered by the Medical Fellowship Board of the National Research Council since 1922, will again be available for the year beginning July 1, 1946. These fellowships, supported by grants from the Rockefeller Foundation to the National Research Council, are designed to provide opportunities for training and experience in research in all branches of medical science. They are open to citizens of the United States or Canada who possess an M.D. or a Ph.D. degree, and are intended for recent graduates who are not yet professionally established.

In addition to these fellowships the Medical Fellowship Board administers two groups of research fellowships, made available through a grant from the National Foundation for Infantile Paralysis, Inc. The first group, open to applicants who hold either the Ph.D. or M.D. degree, is for the purpose of providing opportunities for special training and experience in the study of filtrable viruses. The second group, open only to graduates in medicine who have completed one or more years of hospital experience in clinical surgery and are planning a career in orthopedic surgery, is designed to provide opportunities for training and research in those basic medical sciences that will be of particular value in furthering progress in the field of orthopedic surgery.

A series of fellowships in anesthesiology has been established through a grant from the American Society of Anesthesiologists. These fellowships are offered with a view to fostering a closer union between the clinical practice of anesthesiology and the fundamental disciplines on which anesthesia rests. Applicants must hold the M.D. degree and must have completed one or more years of hospital experience as intern or resident.

Fellows will be appointed at a meeting of the Medical Fellowship Board late in February, 1946. Applications to receive consideration at this meeting must be filed on or before January 1. Appointments may begin on any date determined by the board.

For further particulars address the Secretary of the Medical Fellowship Board, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

NEWS FROM ABROAD

THE following letter dated August 8 from Dr. H. W. Newton, of the Royal Observatory, Greenwich, has been received by Dr. Neal J. Heines, of Paterson, N. J.:

Dear Dr. Heines,

Thank you for your letter of July 16. I regret that I am unable to send anything but a short reply, because my correspondence has to be kept to the very minimum on account of my partial loss of sight from the onset of glaucoma.

The enclosures you send will, I am sure, be of interest to the Director of the Solar Section of the B.A.A. with whom I am in touch.

Thank you also for your expressions of good wishes for our safety at Greenwich. The five and one half years have been very difficult ones though a great experience. The observatory has suffered a considerable amount of superficial damage from blast and a few direct hits, but is safe fundamentally.

With reciprocal good wishes,

Sincerely yours,

H. W. NEWTON

P.S. I have not seen Mrs. Maunder for some time. She has not been very well, I think.

He has also received the following communication, dated September 27, from Dr. W. Runner, of the Astronomical Observatory at Zurich:

Dear Mr. Heines,

Many thanks for your sunspot report for August 1945.

This is the last time I am acknowledging you the receipt of your observations as I shall retire from my duties at the Zurich Observatory and as professor of astronomy at the Federal Institute of Technology and at the university the end of this month. I wish to thank you again for your welcome and useful cooperation at our spot-statistics.

Please address all further correspondence in future directly to the Federal Observatory.

With kind regards and best wishes

Very sincerely yours,

W. RUNNER

Dr. Alfred C. Redfield, of the Woods Hole Oceanographic Institution, has received a poster which was removed from the doors of the University of Tokyo Oceanographic Institute at Moroisi Ko on Sagami Wan by Captain L. S. Parks, Commander Submarine Squadron TWO, on September 2, 1945, while units of that command were engaged in demilitarizing numerous midget submarines located in that area.

This is a marine biological station with her history of over sixty years; If you are from the Eastern Coast, some of you might know Woods Hole or Mt. Desert or Tortugas; If you are from the West Coast, you may know Pacific Grove or Puget Sound Biological Station; This place is a place like one of these; Take care of this place and protect the possibility for the continuation of our peaceful research; You can destroy the weapons and the war instruments; But save the civil equipments for Japanese students; When you are through with your job here, notify to the University and let us come back to our scientific home;

THE LAST ONE TO GO

Captain Parks suggests that it might be of interest to the institutions named to realize that their fame had spread even to enemy territory.

Scientists in general will appreciate this testimony to faith in the international bonds of science and will be grateful to Captain Parks for preserving it.

A letter has been received from Edith Ju-Hwa Chu, D.Sc., professor of chemistry at the National University of Peking, China, who is now in Austin, Texas. She writes:

A letter from Professor Léon Bertin, of *Muséum National d'Histoire Naturelle*, Paris, France, has just been received and it reads as follows: "Answering your letter of November 27th, I am very sorry to inform you, Mr. P. W. Fang passed away in Paris, on the twenty-fifth of August, during a German bombardment. We keep here the remembrance of a very great worker and of the most sympathetic friend."

Mr. Ping-Wen Fang, a research biologist in the Research Institute of Zoology and Botany, the *Academie Sinica, China,* carried on his research in the *Muséum National d'Histoire Naturelle,* Paris, since 1934. He was a specialist in ichthyology and discovered a number of new species of several genera, such as Pheretima, Gobiobotia, Homalopterin loaches, etc., of China. His accidental and untimely death is a great loss to all his friends and to the biological science as well.

News of museums in Munich is contained in a letter from Lieutenant E. T. Boardman, of the Cranbrook Institute of Science:

Maximilineum (housed several science and other cultural societies and their collections). Façade almost intact but gutted. All or most of mineral and fossil collections reported destroyed since the Nazis refused removal of crates of specimens intended for removal.

Alpines Museum (formerly housing material pertaining to natural history and ethnology of the Alpine highlands) now a gutted shell.

Deutsches Kunst Museum (municipal museum of arts and crafts) survived with minor damage. Now converted from a hospital into an American Army mess hall and officer's Post Exchange.

Deutsches Museum (industrial history) has survived structurally and part is in good enough condition to be used for displaced persons. Halls are bare down to masonry in many instances.

The condition of the Museo Civico di Storia Naturale is reported by Professor Oscar de Beaux, director, in a letter to Dr. Robert T. Hatt, Cranbrook Institute of Science:

Our Museum has severely suffered by the war. We had the half of our library burnt away, all the North American and South American papers, the German, Italian, Indian and Australian papers and the entomological works are destroyed. Also a few of the entomological collections and a few of mounted mammal specimens were burnt away or at least strongly damaged by fire. The building was also strongly damaged by fire and explosions. I had to do a hard effort in order to protect what could be protected, and now all is to be begun again.

SCIENTIFIC NOTES AND NEWS

DR. WENDELL M. STANLEY, biochemist of the Rockefeller Institute for Medical Research in Princeton, N. J., has been awarded the 1946 William H. Nichols Medal of the New York Section of the American Chemical Society, in recognition of his work on the chemistry of viruses.

AT the annual dinner in New York City of the American Chemical Society, the Chemical Industry Medal for 1945 was presented to Dr. Sidney D. Kirkpatrick, editor of *Chemical and Metallurgical Engineering,* in recognition of his contributions to the advancement of chemical engineering and research.

DR. HARVEY A. NEVILLE, head of the department of chemistry and chemical engineering of Lehigh University, has been named director of the recently established Lehigh Institute of Research. The institute will continue to conduct cooperative programs of research sponsored by the government, industrial organizations or technical associations. In addition, it is planned to support research programs within the university, which will be supported by funds appropriated for that purpose. Dr. Neville will be assisted by a special advisory committee.

IN continuance of the policy of rotating chairmanships of the University of Oklahoma on September 1, Dr. J. Teague Self replaced Dr. A. I. Ortenburger as chairman; Dr. Francis Hunter, assistant professor of animal biology, on leave of absence while serving in the Armed Forces, will return to his work in January. Dr. Melvin E. Griffith, state entomologist working on control of malaria in war areas for the past three years, has been appointed to an associate professorship in the department. He will develop courses and research in medical entomology when he assumes his new work next September.

DR. J. E. WALTERS, formerly director of personnel, School of Engineering, Purdue University, was inaugurated as the eighth president of Alfred University on November 16. After leaving Purdue University, Dr. Walters was for a time with the Revere Copper Company at Rome, N. Y., eventually as vice-president in charge of personnel. Recently he has been a member of the industrial relations firm of McKinsey and Company, New York City.

DR. E. D. GOLDSMITH has been appointed assistant professor in the department of anatomy of the College of Dentistry of New York University.

DR. MORTON A. SEIDENFELD, who was separated from the United States Army as of November 15, 1945, has been appointed director of psychological services of the National Foundation for Infantile Paralysis, New York, N. Y.

DR. BEVERLY L. CLARKE, formerly director of the analytical department of Bell Telephone Laboratories, Inc., has been appointed director of chemical control at Merck & Co., Inc., manufacturing chemists, Rahway, N. J.

THE University of Minnesota announces that the laboratory of physiological hygiene is undertaking a research program on visual functions and visual fatigue in man as affected by different illuminants. The Verd-A-Ray Corporation of Toledo, Ohio, is sponsoring the project. The work will be conducted by Drs. Ancel Keys, Ernst Simonson and Josef Brozek.

DR. WILLIS L. TRESSLER, of the department of zoology of the University of Maryland and the Chesapeake Biological Laboratory, who has been on leave of absence for the past two years with the Office of Strategic Services, has returned after spending the past several months in China.

PROFESSOR MARTIN MEYER, chairman of the department of chemistry of Brooklyn College, has a leave of absence to serve with the Educational Division of the United States Army as a civilian educational specialist in the European area.

DR. RALPH F. PHILLIPS, assistant professor of organic chemistry at the University of Utah, has been appointed assistant scientific director of the Sugar Research Foundation. Dr. Robert C. Hockett is the scientific director, whom he will assist in the study of the role of sugar in the diet and as a chemical raw material. More than $415,875 in grants have been awarded by the Sugar Research Foundation to leading universities and technological institutes in this country and Canada for research.

FOLLOWING the spring initiation and banquet of the University of Oregon Chapter of Sigma Xi, Dr. Olof Larsell, dean of the Graduate Division and professor of anatomy at the Medical School of the university, gave an illustrated lecture on "The Development of the Cerebellum." The lecture summarized the research work by Dr. Larsell and his coworkers, Dr. Robert S. Dow and Dr. Robert Anderson, on the development of the brain in animals. The following officers were elected for 1945–46: *President,* Dr. T. S. Peterson, associate professor of mathematics; *Vice-president,* Dr. Robert S. Dow, associate professor of anatomy; *Treasurer,* Dr. A. L. Soderwall, assistant professor of biology; *Secretary,* F. P. Sipe, associate professor of biology. A joint banquet and initiation was held with the Oregon Chapter of Phi Beta Kappa on May 19, following which Dr. Herman F. Frankel, professor of classics at Stanford University, gave a lecture on "The Power of Early Greek Thought."

A MEETING held on November 14 of the American Academy of Arts and Science was devoted to the discussion of "A National Policy for Scientific Research." Dr. Lee A. DuBridge, of the Radiation Laboratory of the Massachusetts Institute of Technology; Bradley Dewey, of the Dewey and Almy Chemical Company, and Pendleton Herring, of the Graduate School of Public Administration of Harvard University, led the discussion in which fellows and their guests joined. The various bills now before the Congress were examined and their implications for science and scholarship weighed.

As part of the celebration of the fiftieth anniver-

sary of the discovery of x-rays Sir Lawrence Bragg gave on November 9 a lecture at the Phoenix Theatre, London, on "The Scientific Consequences of Roentgen's Discovery of X-rays."

THE twenty-ninth annual meeting of the Mathematical Association of America will be held at Chicago on Saturday and Sunday, November 24 and 25, in conjunction with the meetings of the American Mathematical Society. The sessions will be held at the Museum of Science and Industry. The sessions of the American Mathematical Society will begin on Friday at 9:30 A.M. and continue through Saturday afternoon. The twenty-seventh colloquium of the society will consist of four lectures on "Length and Area" by Professor Tibor Radó. These lectures are scheduled on Friday at 9:30 A.M. and 2:00 P.M. and on Saturday at 10:00 A.M. and 2:00 P.M. On Sunday morning at 11:00 A.M., by invitation of the Committee to Select Hour Speakers for Western Sectional Meetings, Professor S. M. Ulam will deliver an address entitled "On the Stability of Solutions of Functional Equations." The Josiah Willard Gibbs Lecture will be given on Friday at 7:30 P.M. by Professor J. C. Slater. The title of this lecture is "Physics and the Wave Equation."

THE two hundred and sixty-eighth meeting of the American Physical Society will be held at St. Louis, Mo., in Wayman Crow Hall of Washington University, on Friday, November 30, and Saturday, December 1. There will be a symposium of invited papers on x-rays, arranged in celebration of the fiftieth anniversary of the discovery of x-rays, which coincides within the month.

ANNOUNCEMENT is made of the formation of the "Society for Applied Spectroscopy." The society has been organized by a group of practising spectroscopists working in the New York Metropolitan area who feel the need for an organization which will offer an opportunity for general discussions of the common problems arising in spectroscopic analysis. So far two organization meetings and two program meetings have been held. Meetings will be held on the first Tuesday evening of each month and will consist either of a lecture by some prominent speaker or a symposium on some general topic. At its first two meetings lectures were given by Dr. O. S. Duffendack, of the North American Phillips Co., and Dr. G. H. Dieke, of the Johns Hopkins University. Among the topics to be covered in symposia at the coming meetings are: types of excitation, types of equipment, measurement of radiant energy, absorption spectra and spectroscopic nomenclature. Membership in the society is open to any one having an interest in applied spectroscopy. Those interested can obtain more information from the secretary, Charles L. Guettel, Driver-Harris Co., Harrison, N. J.

DR. TREAT B. JOHNSON, professor emeritus of the department of chemistry at Yale University, has provided by gift two fellowships of $1,000 each for graduate research work in organic chemistry.

TEMPLE UNIVERSITY, Philadelphia, has received a gift of $450,000 from Dr. Theodore L. Chase, a retired Philadelphia surgeon, for the establishment and endowment of a surgical research foundation, with special emphasis on cancer. The gift was presented by Dr. Chase, of Reno, Nev., in memory of his wife, the late Dr. Agnes Barr Chase.

THE Alumni Foundation of the Georgia School of Technology has received a gift of the sum of $100,000 from the Georgia Power Company. It is recommended that the fund be used for the purchase and installation of an a.c. network calculator.

THE Graduate School of the University of Illinois has established four research fellowships to be awarded for one year in the fields of medicine, dentistry and pharmacy in Chicago at a stipend of $1,200 per year (calendar year with one month's vacation). Fellows are eligible for reappointment in competition with the new applicants. Candidates for these fellowships must have completed a training of not less than eight years beyond high-school graduation. This training may have been acquired in any one of the following ways, or the equivalent thereof. Candidates should indicate the field of research in which they are interested and submit complete transcripts of their scholastic credits, together with the names of three former science teachers as references. Appointments will be announced on January 1 or soon thereafter each year. The fellowship year begins on September 1. Formal application blanks may be secured from the Secretary of the Committee on Graduate Work in Medicine, Dentistry and Pharmacy, 1853 West Polk Street, Chicago 12, Ill.

THE Elisabeth Severance Prentiss Foundation of Cleveland has made a grant, which will probably amount to $500,000, to finance a greatly expanded department of biochemistry in the School of Medicine of Western Reserve University. The money will be paid to the university in quarterly payments over a period of ten years, "subject to certain conditions." The chair of biochemistry was left vacant recently by the appointment of Dr. Victor C. Myers as head of a new department of clinical biochemistry. Operating the two new departments, the School of Medicine will follow the British pattern of having one department of biochemistry to carry on research and give instruction in chemistry as it affects all forms

of life, and another to perform a similar function as it affects more direct clinical observation and diagnosis of human illness.

THE Eaton Laboratories of Norwich, N. Y., have given a grant of two thousand dollars to Dr. John C. Krantz, Jr., professor of pharamacology of the School of Medicine of the University of Maryland in support of the general research program of this department.

SPECIAL ARTICLES

THE VITAMIN CONTENT OF CASEIN[1]

As the techniques of nutritional investigations become more refined, it is increasingly important to know the vitamin content of the experimental diets with considerable accuracy. The fat, inorganic salt mixture and sucrose present in a typical purified diet carry at most only traces of vitamins as determined by micro-analytical methods. However, the casein, which is the usual protein source, must be carefully purified, and even after purification it may carry detectable amounts of vitamins. In order to obtain a quantitative measure of the amount which casein may carry, assays for seven of the B-vitamins were made on several representative samples of casein.

The casein samples were: (1) crude commercial casein,[2] (2) alcohol extracted casein, (3) acid washed casein, (4) Labco casein,[2] and (5) Smaco casein.[3] The alcohol extracted and acid-washed casein are routinely prepared in this laboratory from crude commercial casein according to the following methods.

Alcohol extracted casein: A glass-lined pressure cooker with a built-in filter and mechanical stirrer is used. The cooker is charged with 60 liters of 95 per cent. ethanol to which is added with stirring 20 kg of crude casein. The stirring is continued for 2 hours while the temperature is maintained at 75 to 85° C. under pressure. The alcohol is filtered off while hot and a fresh charge of 95 per cent. ethanol is added. The extraction is repeated three times. The casein is thoroughly dried at about 50° C.

Acid-washed casein: Four and a half kg of crude casein are placed in a 20-gallon crock and 65 liters of water are added slowly with continual stirring to avoid formation of lumps. Fifty ml of 1 N HCl is stirred into the mixture and allowed to stand at least 30 minutes. The aqueous layer is syphoned off and the crock refilled with fresh water. Again 50 ml of 1 N HCl is stirred in and the casein allowed to settle for 30 minutes. This procedure is repeated for a total of 8 extractions. The crock is refilled with 65 liters of fresh water and 1 liter of 1.2 N NH_4OH is stirred in. The mixture has the consistency of a thin paste at this point. One N HCl is added slowly with continual stirring from top to bottom until the casein coagulates (pH 4.6). When the casein has settled out, the liquid is syphoned off and the precipitated casein is placed in a cheese-cloth bag. Hot water is run through the mass until it reaches a temperature of 50–60° C. The water is expressed from the casein with a hand press. After final drying on trays at a temperature not exceeding 60° C. the casein is ground in a suitable mill.

TABLE I

THE VITAMIN CONTENT OF CASEIN SAMPLES
(The values are expressed as mgm per 100 gm of casein)

	Thiamine	Riboflavin	Niacin	Pyridoxine	Pantothenic acid	Biotin*	Folic acid	
							S. faecalis	*L. casei*
Crude	0.120	0.360	0.340	0.070	0.450	6.00	0.019	0.013
Alcohol extracted	0.013	0.160	0.085	0.027	0.080	1.79	0.006	0.006
Acid washed	0.023	0.026	0.038	0.012	0.057	1.35	0.003	0.003
Labco	....	0.120	0.074	0.008	0.037	...	0.004	0.008
Smaco	0.016	0.100	0.036	0.026	0.053	0.93	0.008	0.009

* Expressed as micrograms per 100 grams of casein.

Thiamine was determined by the thiochrome method of Hennessy,[4] riboflavin by the fluorometric method of Connor and Straub[5] as modified by Andrews,[6] niacin by the microbiological method of Snell and Wright[7] as modified by Krehl, Strong and Elvehjem,[8] pyridoxine by the yeast growth method of Atkin *et al.*,[9] pantothenic acid by the method of Neal and

[1] Published with the approval of the Director of the Wisconsin Agricultural Experiment Station.

[2] Obtained from the Borden Company, 350 Madison Avenue, New York 17, New York.

[3] Obtained from the SMA Corporation, Chagrin Falls, Ohio. We are indebted to the following individuals who cooperated in this study: G. W. Newell, B. S. Schweigert, W. A. Krehl, L. Glasinovic, Margaret Ives, Anne E. Pollard and Lillian Alberty.

[4] D. J. Hennessy, *Cereal Chemists' Bulletin*, 2: 1, 1942.

[5] R. T. Connor and G. J. Straub, *Ind. Eng. Chem., Anal. Ed.*, 13: 385, 1941.

[6] R. S. Andrews, *Cereal Chem.*, 20: 3, 1943.

[7] E. E. Snell and L. D. Wright, *Jour. Biol. Chem.*, 139: 675, 1941.

[8] W. A. Krehl, F. M. Strong and C. A. Elvehjem, *Ind. Eng. Chem., Anal. Ed.*, 15: 471, 1943.

Strong,[10] biotin by the method of Shull, Hutchings and Peterson,[11] as modified by Shull and Peterson,[12] and folic acid as measured by both *L. casei*[13] and *S. faecalis*.[14] The results are given in Table 1.

It is evident that the four purified caseins carry significantly smaller quantities of all the vitamins studied than the crude casein. The actual amount varies from 1/10 to 1/2 of that present in the unpurified casein. The vitamin content of the four purified caseins is approximately the same except in the case of acid-washed casein, which showed a lower content of riboflavin. The purified caseins used in this study therefore can not be considered vitamin-free. The amount present may not affect the experimental results in most cases, but the amount supplied must be taken into account when vitamin requirements are calculated. The data presented in Table 1 are merely results for specific samples of casein and can not be used for routine calculations since each batch of casein may vary considerably.

While only certain known vitamins have been determined, it is probable that other unknown compounds stimulating the growth of experimental animals may be carried by purified casein. Although the vitamin content of alcohol extracted casein tended to be somewhat higher than that of the acid washed, studies with guinea pigs,[15] dogs and rats receiving sulfa drugs have indicated that alcohol-extracted casein may contain less of certain unknown nutritional factors.

The problem of obtaining a suitable protein source completely free of all growth-stimulating substances other than the essential amino acids has not been solved. The substitution of synthetic amino acids for the natural protein in experimental diets may be one means of solving this problem, but this can not be done without studying the effect of this change on the requirement of other factors.

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[9] L. Atkins, W. L. Williams, A. S. Shultz and C. N. Frey, *Ind. Eng. Chem., Anal. Ed.*, 16: 67, 1944.

[10] A. L. Neal and F. M. Strong, *Ind. Eng. Chem., Anal. Ed.*, 15: 654, 1943.

[11] G. M. Shull, B. L. Hutchings and W. H. Peterson, *Jour. Biol. Chem.*, 142: 913, 1942.

[12] G. M. Shull and W. H. Peterson, *Jour. Biol. Chem.*, 151: 201, 1943.

[13] T. D. Luckey, G. M. Briggs, Jr., and C. A. Elvehjem, *Jour. Biol. Chem.*, 152: 157, 1944.

[14] T. D. Luckey, G. M. Briggs, P. R. Moore, C. A. Elvehjem and E. B. Hart. (In press.)

[15] M. D. Cannon, G. J. Mannering, Marie Zepplin, C. A. Elvehjem and E. B. Hart, *Arch. Biochem.*, 7: 55, 1945.

THE RELATION OF ENDOCRINE GLANDS TO THE GASTRIC SECRETORY DEPRESSANT IN URINE (UROGASTRONE)[1, 2, 3]

THE purpose of this preliminary communication is to present results of experiments on the origin of urogastrone, a gastric secretory depressant in urine, and its relationship to certain of the endocrine glands.

The work to be reported here is part of a systematic investigation of the effect of certain endocrine glands on the production of urogastrone. Three of these endocrine glands, namely, thyroids, ovaries and pituitaries, have been removed to date from different series of dogs and collections of urine made from these animals.

Urine was collected from each of the following series of female dogs: six normal, six oöphorectomized, six thyroidectomized plus oöphorectomized, and separately from two dogs that were hypophysectomized. The transbuccal method for removing the hypophysis was employed on the latter two. Autopsies of these two dogs revealed that the hypophyses were removed. Serial sections of the hypothalamic regions of each brain were also examined and found to be normal.[4]

Urogastrone was prepared by the procedure used in Ivy's laboratory,[5] a modification of the Katzman-Doisy method originally employed by Sandweiss, Saltzstein and Farbman[6] in obtaining their urine extracts of pregnant and of normal women.

The five preparations of urogastrone made from these four series of animals were each tested for their effect on gastric secretion stimulated by histamine in both Heidenhain pouch and gastric fistula dogs. The dogs were fasted at least 24 hours before each experiment.

Between 25 and 53 gastric secretory (double hista-

[1] From Wayne University College of Medicine and the Laboratory of Experimental Surgery, Harper Hospital, Detroit, Michigan. Thanks are due to the Department of Surgery of Wayne University for facilities to carry on this work.

[2] Aided in part by a grant from the Committee on Scientific Research of the American Medical Association, and the Mendelson Fund, Detroit, Michigan.

[3] The valuable surgical assistance of Dr. J. Thorstad and others of Harper Hospital during the early phases of this study is gratefully acknowledged.

[4] The authors wish to acknowledge with appreciation the aid given by Dr. Gabriel Steiner, professor of neuropathology at Wayne University College of Medicine, for his examination of the hypothalamic regions of the brain and the decalcified bases of the skull.

[5] J. S. Gray, E. Wieczorowski, J. A. Wells and S. C. Harris, *Endocrinology*, 30: 129, 1942.

[6] D. J. Sandweiss, H. C. Saltzstein and A. A. Farbman, *Am. Jour. Dig. Dis.*, 5: 24, 1938.

mine) studies were conducted in the usual manner with each of the five extracts, a total of over 200 experiments. Each experiment consisted of two phases: in the first phase, urogastrone was administered intravenously, followed by the subcutaneous injection of histamine. The gastric juice was then collected every ten minutes for a period of seventy minutes and titrated for free and total HCl. Three hours later, in the second phase of the experiment, histamine only was administered and the gastric juice was collected and titrated as previously. In a number of studies these two phases were reversed.

In accordance with previous reports the urogastrone prepared from our normal dogs inhibited gastric secretion in the majority of experiments after histamine injection (inhibition in 63 per cent., augmentation in 18.5 per cent., no change in 18.5 per cent. of the studies). The acidity was also reduced after urogastrone injection, but it did not always correspond exactly to the diminished flow of gastric juice.

Urogastrone prepared from the thyroidectomized plus oöphorectomized dogs inhibited gastric secretion in approximately the same per cent. of the experiments as the urogastrone prepared from our normal dogs referred to above. The extract prepared from the oöphorectomized dogs apparently contained less urogastrone.

The extracts prepared from the two hypophysectomized animals inhibited gastric secretion in only 5 out of 52 studies (9.5 per cent.). What is more important, however, is the fact that in 32 out of 52 studies (61.5 per cent.), there was noted a significant increase in the quantity of gastric juice. The augmentation sometimes reached nearly 200 per cent.

Our results were analyzed statistically by two methods.[7] In the first, our data (*i.e.*, the number of times the volume output of secretion was increased or decreased by the injection of the extract of the urine of normal and of hypophysectomized dogs) were placed in the "four-fold table" and the Chi square was calculated. A value of 21 was obtained, thus indicating that the difference in the effect of the two extracts could occur by chance in less than 1 to 10,000 such cases. In the second, the standard deviation of the means of the HCl output in milliequivalents and the standard error of the difference of the means were computed. This gave a critical ratio of 2.11 which implies that the difference in the milliequivalents of HCl output could occur by chance in less than five times out of 100 similar experiments.

Thus, urogastrone, which is now well recognized as a gastric secretory depressant in normal urine, is also present when both the thyroids and the ovaries are removed. However, if the hypophysis is removed, the depressant is diminished, if at all present, and in a majority of experiments there was an actual increase in gastric secretion following administration of the extract prepared from these animals.

COMMENTS

Clinical studies and impressions appear to indicate that the pituitary-thyroid-gonad mechanism plays a role in human peptic ulcer.[6,8] It is well known that peptic ulcer is comparatively rare in women, but when it does occur, it is ameliorated by pregnancy and aggravated by the menopause.[8] Also, women with ulcer show a high incidence of endocrinopathies.[8] While ulcer in the adult is approximately five to ten times as frequent in men as it is in women, in children before puberty, though rare, it is equal in both sexes. Of interest also, is the fact that extracts prepared from urine of both pregnant and normal women have a greater prophylactic, therapeutic and "immunizing" effect on the experimental Mann-Williamson ulcer in dogs,[6,8,9] than extracts of urine from normal men. It is therefore probable that in the female the monthly reproductive cycle and the increased glandular function during active sex life and pregnancies (*i.e.*, the chemical interplay between the pituitary and the ovaries throughout the active menstrual life of the female), augment the production of ulcer "protective factors" and thus serve to prevent or benefit "peptic" ulcer. The absence of these in the male could result in the lesser protection against ulcer. Abnormalities in the glandular function in both the male and the female may affect the protective factors and be responsible for ulcer formation.

Our preliminary data are indicative of a relationship between the pituitary gland and gastric secretion. When the gland is removed, the dog's urine contains very little, if any, of the gastric secretory depressant. In addition, when its urine extract is administered to Heidenhain pouch or fistula dogs an increase in the quantity of gastric juice is noted. This may suggest that with a disturbance in the pituitary gland, factors come into greater play that augment the action of gastric secretory stimulants, and contribute to ulcer formation.

Further work is now in progress on the relationship of the pituitary gland to "peptic" ulcer.

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[7] The authors wish to express their appreciation to Dr. A. C. Ivy, of Northwestern University, and his staff for their assistance in the statistical analysis of our data.

[8] D. J. Sandweiss, H. C. Saltzstein and A. A. Farbman, *Am. Jour. Dig. Dis.*, 6: 6, 1939.

[9] D. J. Sandweiss, *Gastroenterology*, 1: 965, 1943.

PRECIPITATION OF FERRIC HYDRATE BY IRON BACTERIA[1]

INFORMATION concerning the physiology of iron bacteria is still very incomplete, and as a consequence there is confusion as to whether or not any of the bacteria which are encountered in iron-bearing waters are concerned directly or indirectly in the precipitation of iron from the waters. Even if it is assumed that some of the bacteria are responsible for the precipitation of ferric hydrate, it is difficult to establish with certainty the reactions whereby the precipitation is effected.

Few of the iron bacteria have as yet been cultivated in artificial media,[2, 3, 4, 5, 6, 7] and in only a few instances is there more than meager evidence that the bacteria oxidize inorganic ferrous iron to ferric iron and utilize the energy thus liberated for growth. On numerous occasions slimy filamentous material which appears in water basins has been referred to as "iron bacteria," even though there may have been relatively little ferric hydrate associated with the cell material.

There is reason to believe that some of the iron bacteria are strict autotrophs, particularly the species of *Gallionella*. Some of the other iron bacteria such as certain species of *Leptothrix* and *Crenothrix* may be facultative autotrophs.[5] Still other bacteria, which should not be called "iron bacteria," precipitate iron as a result of the decomposition of organic iron compounds. With the bacteria of the last group the iron plays no role of particular importance in the development of the bacteria, since the energy that the bacteria utilize is obtained by the oxidation of the organic portion of the compounds.

According to Winogradsky's concept of iron bacteria,[8, 9] only bacteria that are able to grow from the energy liberated by the oxidation of inorganic compounds of ferrous iron to ferric hydrate should be called "iron bacteria." There is still considerable uncertainty as to how many genera and species would qualify as iron bacteria according to this definition. Although many other organisms are concerned with the precipitation of ferric hydrate, all the iron bacteria are characterized by the accumulation of an abundance of ferric hydrate. The reaction by which they are presumed to grow yields very little energy, and, since the product of their oxidation is insoluble, voluminous accumulations of ferric hydrate characterize their development. Winogradsky stated that there might be as much as 100 times as great an amount of ferric hydrate as cell material of the bacteria.[9] The following calculations suggest that this is a conservative estimate.

The reaction which characterizes these bacteria is the following:

$$4FeCO_3 + O_2 + 6H_2O = 4Fe(OH)_3 + 4CO_2 + 40 \text{ Cal.}$$

According to this reaction 10 calories are released for each gram atom of ferric carbonate oxidized or for 55.8 g of iron in the form of ferrous carbonate.

It has been found that the efficiency of the conversion of bicarbonate carbon to cell material by various autotrophic bacteria varies between 5 and 10 per cent.[10] That is, only 5 to 10 per cent. as much energy is represented in the organic compounds of the bacterial cells as is released by these organisms during their growth on the energy obtained by the oxidation of their specific inorganic sources of energy. The efficiency of *Thiobacillus thiooxidans*, which has been studied more thoroughly than that of any of the other autotrophic bacteria,[11, 12] has been calculated to be about 8 per cent.[10, 11]

It requires 690 calories to produce one gram molecule of glucose from carbon dioxide and water or 115 calories to transform one gram atom or 12 grams of carbon to cell material according to the following reaction:

$$6CO_2 + 6H_2O = C_6H_{12}O_6 + 6O_2 + 690 \text{ Cal.}$$

It may be assumed, without greatly affecting the accuracy of the calculations, that the organic material of the cells is glucose. Since the cell material is somewhat more highly reduced than glucose, slightly more energy would be required than that indicated by the reaction whereby glucose is synthesized from carbon dioxide and water.

As stated above, 10 calories are liberated by oxidation of 55.8 g of iron in the form of ferrous carbonate. If the process of carbon assimilation is only 8 per cent. efficient, only 0.8 calories would be represented by the organic material in the cells of the bacteria produced by this oxidation. The amount of carbon assimilated by this amount of energy would be

$$\frac{0.8}{115} \times 12 = 0.0835 \text{ g.}$$

Assuming organic material similar to that of carbohydrate, the amount of organic material represented

[1] Journal Series Paper of the New Jersey Agricultural Experiment Station, Rutgers University, Department of Microbiology.

[2] H. Molisch, "Die Eisenbakterien." Jena: Gustav Fischer. 83 pp. 1910.

[3] R. Lieske, *Jahr. f. wiss. Botanik*, 49: 91–127, 1911.

[4] R. Lieske, *Cent. Bakt. etc.* II, 49: 413–425, 1919.

[5] N. Cholodny, "Die Eisenbakterien." Jena: Gustav Fischer. 162 pp. 1926.

[6] M. S. Cataldi, *Folia Biol.* (Buenos Aires), October-December, 1937–38, Nos. 79–82.

[7] M. S. Cataldi, "Estudio fisiologico y sistematico de algunas Chlamydobacteriales." Thesis, University of Buenos Aires, Argentina. 96 pp. 1939.

[8] S. Winogradsky, *Bot. Zeit.*, 46: 262–270, 1888.

[9] S. Winogradsky, *Cent. Bakt.*, etc., II, 57: 1–21, 1922.

[10] L. G. Baas-Becking and G. S. Parks, *Physiol. Rev.*, 7: 85–106, 1927.

[11] R. L. Starkey, *Jour. Bact.*, 10: 135–163; 165–195, 1925.

[12] R. L. Starkey, *Jour. Gen. Physiol.*, 18: 325–349, 1935.

by this amount of carbon would be $\frac{5}{2} \times 0.0835 = 0.2088$ g. Thus, from the oxidation of 55.8 g of iron as ferrous carbonate, there would be formed 106.8 g of ferric hydrate but only 0.209 g of organic cell material. The ratio of the weight of ferric hydrate to the weight of the cell material would thus be about 500 to 1. It is apparent that if these bacteria have efficiency similar to that of other autotrophic bacteria the organic cell material will be only a fraction of the amount of ferric hydrate produced by the oxidation process. Even assuming that the organic cell material contains a greater percentage of water than that of the ferric hydrate and allowing for the higher specific gravity of the ferric hydrate, the volume of the ferric hydrate would be many times as great as that of the organic portion of the bacterial cells.

It can be concluded that, under conditions where iron bacteria grow at the expense of the oxidation of ferrous iron, there will be large quantities of ferric hydrate. It seems unreasonable, therefore, to conclude that an organism is an iron bacterium or that it is developing as an iron bacterium unless there are far greater quantities of ferric hydrate than cell substance in the accumulated materials resulting from bacterial growth. There is reason to conclude that, where most of the products of bacterial development consist of organic filamentous material and slimes, these bacteria have grown upon organic materials instead of ferrous iron.

There are so many reactions whereby iron may be precipitated from iron-bearing waters without the participation of iron bacteria[13, 14] that it is not safe to conclude upon the basis of iron precipitation alone that the product was formed by iron bacteria. Although not all cases of iron precipitation from water are due to iron bacteria, an abundant precipitation of ferric hydrate can be expected whenever the iron bacteria are growing by the oxidation of inorganic ferrous compounds.

There is great need for additional information on the physiology of the iron bacteria, and until more specific information is obtained it seems certain that there will be confusion regarding the identity of iron bacteria, the reactions with which they are concerned and their importance in the precipitation of ferric hydrate in nature.

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SHORT AND LONG FOOD CHAINS AMONG VEGETABLE CROPS

"LENGTH of food chain" refers to the number of animal organisms that have consumed the original food produced by plants before it is used in human metabolism. The consumption of plants would be considered a "short chain," that of meat and fish a "long chain," since animals must live on organic material produced originally by plants. Our vegetable plants seem to show an analogous relation when one compares the efficiency of those that furnish a vegetative part for food and those that furnish a fruit part. Thus, our fruit crops are those in which fertilization usually occurs before the eatable portion is produced. Vegetative crops are those where the root, stem, leaf and immature flower parts (cauliflower, broccoli and globe artichokes) are consumed.

Cabbage, carrots, potatoes, spinach and similar vegetative crops appear to use food value, land and labor resources more efficiently than fruit crops such as watermelons, sweet corn and cucumbers. In the first group the original vegetative organs are used as food; in the second, the vegetative parts are not eaten directly, but produce an edible fruit. Thus our common foliage, stem, root and immature flower crops could be considered a "short chain"; our vegetable fruit crops a "long chain."

An extreme case of a long food chain has been cited by Kunkel[1] in connection with the food habits of the Eskimo. There are four organisms involved in this chain: the Eskimo lives largely upon seal meat, the seals eat fish, the fish consume snails and other invertebrates, and these in turn feed upon seaweeds. About 625 pounds of seaweed is required originally to produce a gain of 1 pound in the weight of the Eskimo. If the Eskimo would eat fish instead of seal meat, the chain would be shortened, and only 125 pounds of seaweed would be required. In pork production the data are expressed in different terms; but, as Hogan, Weaver, Edinger and Trowbridge[2] have pointed out, only about 40 per cent. of the energy consumed is stored in the animal's tissues. The same workers find that only about 10 per cent. of the protein consumed was stored in the tissues of the swine in this experiment. These values would vary somewhat with the age of the animals and with feeding conditions.

Foods for livestock may be classified into three groups on the basis of the competition between meat-producing animals and human beings. First, there are foods that may be used either by livestock or people, such as wheat and corn. Second, there are livestock feeds which are not usable by people, but which are grown upon land that could have produced human food; an example is alfalfa hay on irrigated

[13] H. O. Halvorson, *Soil Sci.*, 32: 141–165, 1931.
[14] R. L. Starkey and H. O. Halvorson, *Soil Sci.*, 24: 381–402, 1927.

[1] B. W. Kunkel, *Scientific Monthly*, 46: 47–58, 1938.
[2] A. G. Hogan, L. A. Weaver, A. T. Edinger and E. A. Trowbridge, *Mo. Agr. Expt. Sta. Res. Bul.* 73, 1925.

land. Third, there are ranges, considerable pasture and many by-products that can be utilized only as livestock feed.

Some recent studies[3, 4, 5] have furnished data for comparing the efficiency of thirty vegetable crops with reference to their food value and to the use of resources such as land and labor. The tables published show the quantity of the nine nutrients per pound as purchased, and also the nutrients produced per acre and per man-hour. These tables were prepared from the following data: (1) chemical composition of the edible portion; (2) relative amount of edible portion in a purchased vegetable; (3) average yield per acre, and (4) hours of work required to produce average yields. Each of the nine essential nutrients (energy sources, protein, calcium, iron, vitamin A, ascorbic acid, thiamin, riboflavin and niacin) was expressed in terms of the recommended dietary allowances of the National Research Council, in which the daily need for each constituent was considered as a unit. The tables on food value per pound as purchased, per acre and per man-hour were first treated by ranking the amounts of each nutrient in all the vegetables. The data were summarized by giving the first rank to the vegetable occurring most often near the first rank and by arranging the others in a descending order. This system gives a superior rating to crops high in most of the nine nutrients rather than a crop that is merely high in one nutrient. Table 1 summarizes this study. This relation among vegetables seems to be largely confirmed by common experience, and the procedure followed was chosen as apparently the most accurate method thus far developed.

According to the results of this procedure (Table 1), the most efficient crops are those in which the vegetative part is eaten, for example, root, stem, leaf or immature flower parts. Group 1 comprises the 7 most efficient crops, 6 of these being vegetative and 1 a fruit crop; group 2 comprises the 6 next most efficient, 5 being vegetative and 1 a fruit crop; group 3, next in line, has 6 vegetative and 4 fruit crops; but in group 4, the least efficient, there is only 1 vegetative crop, whereas 6 are fruit crops. According to this evidence if the vegetative parts are used as food they are produced more efficiently than if a plant needs to produce first a vegetative unit and then a fruit. The vegetative plants are largely cool-season crops, which either are grown entirely in cool weather or must have cool weather at some critical time in their growth. According to an old saying of gardeners, the "cool-season" plants are those desired for their vegetative part (with the exception of peas). The "warm season" plants are those raised for the fruit part (with the exception of sweet potatoes). These two generalizations apply to our common vegetables.

TABLE 1

RELATIVE EFFICIENCY OF VARIOUS VEGETABLES AS FOOD PRODUCERS, BASED ON THEIR RANK IN NUTRIENTS PER POUND, PER ACRE AND PER MAN-HOUR

	Rank in nutrients per			Part of plant eaten		
	Pound	Acre	Man-hour	Vegetative	Fruit	Cool-season crops
Crops ranking 1–15 in nutrients per pound, per acre and per man-hour:						
Group 1:						
Broccoli	1	5	7	+		+
Cabbage	14	6	4	+		+
Mustard greens.	2	1	2	+		+
Spinach	11	12	8	+		+
Sweet potatoes .	3	13	5	+		
White potatoes .	8	2	3	+		+
Winter squash .	15	11	1		+	
Crops ranking 1–15 in two of the following: nutrients per pound, per acre or per man-hour:						
Group 2:						
Beets, bunch ...	26	4	15	+		+
Brussels sprouts	4	14	24	+		+
Carrots, bunch .	25	7	13	+		+
Onions	16½	3	6	+		+
Tomatoes, market	13	15	17		+	
Turnips, bunch .	21	10	12	+		+
Crops ranking 1–15 in one of the following: nutrients per pound, per acre or per man-hour.						
Group 3:						
Artichokes	12	30	22½	+		+ +
Cauliflower	20	17	9	+		+ +
Casabas and honeydews	27	21	11		+	+
Celery	24	8	22½	+		+
Green asparagus	7	29	26	+		+ +
Lettuce	22½	18	14	+		+ +
Lima beans	10	22	27		+	+
Peas	6	28	29		+	+ +
Snap beans	5	19	30		+	+
White asparagus	9	31	28	+		+ +
Crops ranking 16–31 in nutrients per pound, per acre and per man-hour.						
Group 4:						
Bell peppers ..	19	20	19		+	
Cantaloupes ...	28	24	18		+	+
Cucumbers	29	23	25		+	+
Radish	30	25	31	+		+ +
Summer squash.	18	16	20		+	+
Sweet corn	22½	26	16		+	+
Watermelon ...	31	27	21		+	+

Interpretation: The accuracy of the data do not permit making distinctions between small differences. Vegetables in group 1 are thought to be more efficient than those in groups 3 and 4; group 2 is considered more efficient than group 4.

[3] John H. MacGillivray, Arthur Shultis, G. C. Hanna and Agnes Fay Morgan, *Calif. Agr. Exp. Sta. Offset Pub.*, September, 1943.

[4] John H. MacGillivray, Arthur Shultis, A. E. Michelbacher, P. A. Minges and L. D. Doneen, *Calif. Agr. Exp. Sta. Offset Pub.*, September, 1943.

[5] John H. MacGillivray, Agnes Fay Morgan, G. C. Hanna and Arthur Shultis, *Calif. Agr. Exp. Sta. Offset Pub.*, December, 1943.

Quality often depends upon harvesting the vegetables at the proper stage of development. All crops that need punctual harvesting fall within groups 3 and 4. During periods of inadequate labor or unfavorable weather, this is a further disadvantage of groups 3 and 4.

In the past, the importance of root, stem and leafy crops from a dietetic standpoint has been pointed out largely on the basis of individual crops. As Table 1 shows, high food value and efficient use of labor and land areas is a general characteristic of this group of vegetables. An average diet contains 739 pounds of plants out of a total consumption of 1,420 pounds of food. About a third of our plant food is vegetative portions of vegetables; the remainder is vegetable, grain and tree fruits. Unfortunately, data are available to test this hypothesis only in our vegetable plants. Vegetables, despite their low energy and protein content, have praiseworthy qualities for improving our diet, whether they are produced commercially or in a home garden. The high efficiency of these plant parts as food calls attention to the fact that only in the case of vegetables do the American people consume a vegetative part of the plant.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE DESTRUCTION OF PYROGENS BY HYDROGEN PEROXIDE

PYROGENS are toxic, non-dialyzable substances formed by various micro-organisms. They are relatively stable in boiling water and cause prompt temperature rises in animals when injected in microgram doses. In man, Co Tui[1] estimates that an intravenous dose of 0.02 micrograms of typhoid pyrogen per kilogram of body weight will provoke a rise in body temperature of 0.5–0.6° C.

The necessity for the complete absence of pyrogens from solutions intended for parenteral administration is well recognized,[2] but many substances injected parenterally, especially in investigative work, are not available in pyrogen-free form. Practicable methods for removing pyrogens are therefore of utility, and several such methods have been described. For example, Co Tui and Wright[2] have recommended adsorptive filtration with Seitz filters, although Francke and Rees[3] found preliminary treatment with powdered charcoal before Seitz filtration to be required for complete removal of pyrogens from solutions of inulin. Seitz filtration was also found unsatisfactory for removing pyrogens from enzymatic hydrolysates of protein by Zittle *et al.*,[4] who resorted to heating with acid to destroy the pyrogens.

Since no satisfactory general method for removing pyrogens from all solutions appears to have been found, our observation that pyrogens can be destroyed by heating with dilute hydrogen peroxide may prove

TABLE 1

EFFECT OF HYDROGEN PEROXIDE TREATMENT UPON PYROGEN ACTIVITY

Pyrogen preparation	Source	Concentration of H_2O_2	Heating		pH		Rectal temp. rises (°C.)	Average rise (°C.)[4]
			Time (min.)	Temp. (°C.)	Before heating	After heating		
A[1]	*Pseudomonas aeruginosa*	0	30	100	6.58	6.66	1.25, 1.25, 1.60	1.37
		0.001 M	30	100	...	...	1.50, 1.55, 2.25	1.77
		0.01 M	30	100	6.82	6.75	0.80, 1.05, 1.10	0.98
		0.1 M	60	100	6.21	6.64	0.00, 0.20, 0.40	0.20
B[2]	*Pseudomonas aeruginosa*	0	20	100	7.26	6.88	0.95, 1.40, 2.25	1.53
		0	120	100	7.28	7.02	0.70, 1.05, 1.40	1.05
		0.01 M	120	100	7.27	6.99	−0.10, −0.10, 0.15	0.05
		0.1 M	120	100	7.33	6.88	−0.15, −0.05, 0.35	0.12
C[3]	Gelatin	0	120	100	7.20	7.19	0.95, 1.10, 1.10	1.05
		0.1 M	120	100	7.03	6.51	0.25, 0.60, 0.80	0.55
		0.1 M	120	100	7.16	5.12	−0.25, −0.10, 0.00	0.00
D[3]	Gelatin	0	20	116	...	...	0.60, 0.75, 0.85	0.73
		0.04 M	20	116	...	...	0.00, 0.15, 0.20	0.12

[1] Pyrogen solution prepared by U. S. Food and Drug Administration for First Collaborative Assay (H. Welch, H. O. Calvery, W. T. and McClosky and C. W. Price, *Jour. Am. Pharm. Assoc.*, 32: 65, 1943), diluted 1:10 with 0.9 per cent. NaCl solution.

[2] Dried concentrated pyrogen from *Pseudomonas aeruginosa*, kindly supplied by Dr. Henry Welch, U. S. Food and Drug Administration dissolved in 1:100,000 dilution in 0.9 per cent. NaCl solution buffered with sodium phosphate.

[3] Commercial gelatin, in approximately 5 per cent. solution in distilled water.

[4] Negative values considered as zero temperature rise, in calculating averages.

[1] Co Tui, D. Hope, M. H. Schrift and J. Powers, *Jour. Lab. Clin. Med.*, 29: 58, 1944.

[2] Co Tui and A. M. Wright, *Ann. Surg.*, 116: 412, 1942.

[3] D. E. Franke and V. L. Rees, *Jour. Am. Pharm. Assoc.* (Pract. Pharm. Ed.), 4: 158, 1943.

[4] C. A. Zittle, H. B. Devlin, G. Rodney and M. Welcke, *Jour. Lab. Clin. Med.*, 30: 75, 1945.

useful for specific applications. The action of hydrogen peroxide might also be utilized in the study of the chemical nature of pyrogens.

Pure pyrogens have not yet been isolated and their chemical structure has therefore not been fully established, but the properties of partly purified preparations have received considerable study.[1,5-7] The evidence indicates that pyrogens are neither proteins nor protein split-products and that highly purified preparations may contain no nitrogen whatsoever.[7] Purified preparations exhibit the properties of polysaccharides which can be hydrolyzed to reducing sugars.

The effect of oxidizing agents upon pyrogens appears not yet to have been studied, although in 1930 Carter[8] proposed heating with dilute permanganate solution as a test for the presence of pyrogens in water, on the theory that pyrogens are oxidizable bacterial products. Although the permanganate test has since been proved totally inadequate, because it is not specific and is insufficiently sensitive, Carter's surmise that pyrogens can be readily oxidized may be correct. In 1912, Hort and Penfold[9] observed that if centrifuged cells of *B. typhosus* were washed with hydrogen peroxide, their injection no longer produced the fever which followed injection of similar cells washed with water. Presumably the pyrogens in the cells were destroyed by the peroxide, but the concentration employed was not stated.

In the course of an investigation of plasma substitutes, one of us (D. H. C.) observed that pyrogenic solutions of gelatin were rendered non-pyrogenic by heating with potassium permanganate or hydrogen peroxide. This effect was studied further using two different preparations of partially purified pyrogens in addition to two lots of pyrogenic gelatin. The pyrogen content was estimated by intravenous injection, into each of three rabbits, of 10 cc of solution per kilogram of body weight. Control rectal temperatures were measured within 30 minutes prior to the injection and the temperatures were again measured 1, 2 and 3 hours after the injection. A rise of 0.6° C. or more is regarded as positive indication of the presence of pyrogens.[1,4]

The results summarized in Table 1 show that no significant rise in temperature followed injection of pyrogenic solutions which had been heated at 100° C. for 60–120 minutes in the presence of 0.1 M-hydrogen peroxide, whereas control solutions heated without peroxide caused rises of 0.60–2.25° C. Even at 0.01 M concentration, the peroxide caused a decrease in the temperature response. That the change effected by the peroxide was not due to alteration of pH is shown by the results for Preparation B, the solutions of which were all at essentially the same pH.

On the basis of these results, it is suggested that treatment with hydrogen peroxide might be of practical use in rendering solutions non-pyrogenic, where the peroxide does not adversely affect other constituents of the solution and where the amount used is sufficient to destroy the pyrogens present without leaving a deleterious excess.

Further work on the chemistry of the oxidation reaction is being planned for as soon as reasonably pure pyrogenic material is available.

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STIRRER BEARING FROM BROKEN HYPODERMIC

MOST chemists have felt the need of a device to supplant the clumsy and frequently inadequate mercury seal stirrer. It has been found possible in these laboratories to eliminate almost completely the use of such seals by the use of a bearing constructed from a hypodermic syringe. The method of utilization is to cut off both ends of the plunger and the closed end of the barrel. The barrel is then inserted in the rubber stopper and acts as the outer bearing. The stirrer shaft is then passed through the converted plunger and sealed into it either by means of rubber tubing or a small stopper, depending on the relative size of the syringe and stirrer shaft. A light lubricant such as vaseline or glycerine should be used. Under these conditions, the bearing may be used with a relatively high-speed stirrer and has proved adequate for pressures as low as 6 mm.

Even where it is necessary to purchase a new syringe for this purpose, it will be found to be a worthwhile investment, as the syringes are usually stoutly constructed and quite durable. However, by arrangement with a hospital a more than adequate supply of damaged or defective syringes suitable for this purpose usually may be obtained.

No credit is claimed here for originating this device as it appears to have been used for some time in other laboratories. Inquiry has shown, however, that knowledge of it is extremely limited, and there appears to be no mention of it in the literature. Hence we feel that the publication of its description should serve a useful purpose.

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[5] H. M. Banks, *Am. Jour. Clin. Path.*, 4: 260, 1934.
[6] E. Centanni, *Deut. Wochschr.*, 66: 263, 1940.
[7] E. S. Robinson and B. A. Flusser, *Jour. Biol. Chem.*, 153: 529, 1944.
[8] E. B. Carter, *Jour. Lab. Clin. Med.*, 16: 289, 1930.
[9] E. C. Hort and W. J. Penfold, *Jour. Hygiene*, 12: 361, 1912.

DISCUSSION

THE WAR AND SCIENCE IN THE PHILIPPINES[1]

BEFORE the war, most of the modern sciences had attained a considerable degree of advancement in the Philippine Islands. The seats of much of the progress in the various fields were located in the Bureau of Science, certain other governmental branches and the University of the Philippines. These organizations, largely instituted by Americans a few decades ago, had in recent years become almost completely staffed and controlled by Filipinos. Excellent work was being done by specialists in many fields. The *Philippine Journal of Science,* one of the foremost scientific publications in Asia, was published by the Bureau of Science. Many American biologists, well known in connection with their scientific work in the Orient, among them E. D. Merrill, A. W. Herre, E. B. Copeland and the late R. C. McGregor, contributed to the building up of this journal, and the high standards were maintained by their Filipino successors.

The effect of World War II on these institutions is very depressing. The Japanese occupation seriously slowed down work and interfered with the financing of the various institutions. The Japanese army sent the well-known Japanese zoologist, Professor Hatai, of Sendai Imperial University, to Manila, with the rank of major-general, to supervise scientific work. In the summer of 1944, one number of the *Philippine Journal of Science* was published, the first since the September number of 1941. It contained articles by local specialists, and did not include any of the articles by Americans which were on hand or in press at the commencement of the war. Among the latter were articles by Copeland, Alexander, Gressitt and others.

When the American forces approached Manila at the beginning of 1945, the Japanese systematically destroyed the Bureau of Science, the Philippine National Museum and the University of the Philippines, all located at or near Taft Avenue and Herran Street. All the buildings were fired and only a single room escaped burning. This was a room in which some of the older publications of the Bureau of Science, mostly special publications and ten-year indices of the *Philippine Journal of Science,* were stored. Nearly all the stock of back numbers of the journal was destroyed. Some of the more recent ones, not yet inventoried, may still be at the Bureau of Printing, which is in another part of Manila and was not burned. Two of the three buildings of the Bureau of Science collapsed, and the third was gutted but may be repaired. The library and collections were completely destroyed, the latter including many type specimens, particularly of helminths. Several of the university buildings were completely destroyed. One burned-out building adjacent to the Bureau of Science is now being used as administration building and also for classes. The Philippine General Hospital buildings are for the most part standing, and are being used both as hospital and medical college.

The College of Agriculture of the University of the Philippines, at Los Baños, was partly used by the Japanese as a civilian internment camp for Americans. During or before the American liberation, some of the buildings were damaged, and practically all the equipment, collections, library and animals were destroyed. Much of the more permanent experimental plantings were preserved. Two of the buildings are now being used for administration and classes, and some of the others are still occupied by American Army units. Dr. Uichanco, the dean of the college and the best-known Filipino entomologist, was tortured by the Japanese in connection with his aid to Filipino guerrillas and American civilian internees. His shoulder was dislocated and he was hospitalized for over five months. On another occasion, he narrowly escaped a massacre. He is now back at his job.

Of approximately fifty specialists in the Bureau of Science and related governmental organizations, about one half have returned to their work, even though they are without equipment. Some of the others are working temporarily at other jobs. Dr. H. A. Roxas, zoologist, died a natural death during the war, and the following five were killed by the Japanese or died as a result of the war: Dr. C. M. Africa, parasitologist of the Institute of Hygiene; Dr. Lamberta Leiva, retired parasitologist; Dr. Miguel Manresa, of the Animal Husbandry Department of the College of Agriculture; Dr. S. Del Mundo, chemist of the Bureau of Science; and Dr. Jose B. Juliano, a botanist of the Natural History Museum.

Dr. Rafael H. Aguilar, chemical engineer, is temporarily acting as officer in charge of the Bureau of Science. The former director, Dr. Angel S. Arguelles, is not now with the bureau. Dr. Augustus P. West, an American, head of the Division of Organic Chemistry of the Bureau of Science, has returned to America after release from Japanese internment. The following specialists are among those at present with the Bureau of Science: Dr. Eduardo Quisumbing, head,

[1] The Bureau of Medicine and Surgery of the Navy does not necessarily endorse the views set forth in this paper.

Division of Botany, and also head of the Natural History Museum of the Department of Agriculture and Commerce and editor of the *Philippine Journal of Science;* Dr. M. A. Tubangui, parasitologist and head of Division of Microbiology; Dr. Mariano Basaca, bacteriologist; Dr. Joaquin Marañon, chemist, head of Division of Tests and Standards; Mr. Rafael Simpao, chemist; Mr. A. O. Cruz, chemist; Mr. Gil Opiana, ceramics; and Mr. F. D. Maramba, engineer.

In the Department of Agriculture and Commerce, Dr. Deogracias V. Villadolid, ichthyologist, is head of the Division of Fisheries, and Dr. Marcos M. Alicante, soil chemist, is head of the Division of Soil Survey. Others in the Natural History Museum, under the same department, include Dr. Canuto G. Manuel, ornithologist, and Mr. Jose Mendoza, mycologist.

Among the professors at the College of Agriculture of the University of the Philippines at Los Baños are the following: Dr. Leopoldo B. Uichanco, dean and head, Department of Entomology; Professor Silverio M. Cendaña, entomology; Dr. Francis A. Santos, head, Department of Agricultural Chemistry; Dr. Leopoldo Villanueva and Dr. Julian Banzon, agricultural chemistry; Dr. Dionisio I. Aquino, head, Department of Soils, and Dr. Nicolas Galvez, soils; Dr. Gerardo O. Ocfemia, head, Department of Plant Pathology; Dr. Francis M. Sacay, head, Department of Agricultural Education, and Professor Andres Aglibut, agricultural education; Dr. Rafael B. Espino, head, Department of Botany; Dr. Anastacio L. Teodoro, head, Department of Agricultural Engineering, and Professor Alejandro Catambay, agricultural engineering; Dr. Leon Gonzales, head, Department of Agronomy, Dr. Pedro A. David and Dr. Jose M. Capinpin, agronomy; Dr. Valente Villegas, head, Department of Animal Husbandry, and Dr. Mariano Mondoñedo, Professor Felix B. Sarao, Dr. Francisco M. Fronda, Dr. Lorenzo P. Zialcita, animal husbandry. The last named returned from America on the staff of President Osmeña at the time of the liberation. These specialists are desirous of resuming communication with their correspondents in the United States, and are particularly anxious to receive reprints of scientific papers in their fields.

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THE AIR FORCES' COLLECTION OF AERIAL PHOTOGRAPHS

DURING the course of the war and previously the Army and Navy Air Forces have accumulated a collection of aerial photographs covering a very substantial part of the earth's land surface. Aerial mapping has developed to an extent where it will largely supersede conventional mapping from ground surveys. The art of interpreting aerial photographs in terms of vegetation, geological structure and even depth of water, as well as cultural features, before the war in a more or less experimental stage, has developed into a powerful tool to be used in many branches of research in geography, geology, botany, ecology and conservation, as well as being indispensable in modern exploration.

The actual extent of coverage of the earth is not yet known and will not be for many months. The negatives are still coming in to Washington from all theaters of Army and Navy activity. They must be rewashed to insure against deterioration. Prints must be made and examined. Data must be assembled and the negatives catalogued. This is an enormous task that may well continue for several years before any one has an adequate idea of the full value of this photographic collection.

Since the greater part of this aerial coverage is of overlapping shots it may be studied stereoscopically, bringing out detail undreamed of in ordinary examination of single prints. The mapping of vegetation types made possible by this technique will lay the foundation for a complete and detailed knowledge of the plant covering of the earth, even in regions hitherto practically unknown. Much information on physiography and such structural geology as may be deduced from physiography will become available, laying the foundation for intensive study on the ground. Much time may thus be saved and a far more dependable framework for all types of geological studies will be provided than ever has been available before. For geography and ecology, not only will there be suddenly available an enormous amount of basic data, but a reference point in time may be established from which to study and measure changes of many types and magnitudes over both long and short periods of time. The greater portion of the negatives being on cellulose acetate film, they may be expected to last without recopying for periods of hundreds of years. Basic to all branches of science, material is now available for detailed mapping of the earth's surface, and methods of preparing such maps are far more satisfactory than ever before.

It is, of course, unnecessary to urge the value of this accumulation of photographic data to any one who has any idea of its extent and quality. It will suffice merely to indicate its existence to those who are not aware of it. The important question to be posed by this article is that of the future preservation and availability of this material. Many of the scientists who have some knowledge of the collection are expressing concern as to what shall become of it.

It would be a tragic waste if, although millions of dollars in materials, equipment, planes, gasoline and flyers' and photographers' time, and even some lives, have been spent in acquiring the material, it were allowed to deteriorate from lack of care or to be destroyed because of lack of a place to house it.

Military authorities are likely to fail to have much consideration for or interest in non-military uses of their apparatus and equipment. Their job is to defend the country, and such things as do not bear directly upon this do not necessarily carry much weight with them. Those at present in charge of the units that have jurisdiction over this material are keenly aware of and interested in its peacetime preservation and use. They do not yet have proper facilities for housing and filing of the negatives. There is, furthermore, no assurance that those at present actively working with the collection will not leave the services and return to civil life as soon as they are permitted to. What would happen to the material if an officer who did not understand or appreciate its full value were placed in charge is highly uncertain. Scientists have ample reason to be concerned about this in view of what has sometimes happened in the past, not only in military agencies but in certain civilian ones.

It is theoretically the duty of the National Archives to handle all material of this sort. The officials of this agency of the government are at present actively concerned with this very problem. They have, however, inadequate facilities both for going to the agencies in possession of such material and asking for it, and for housing it should it be offered to them. It would, furthermore, be too late to assert their jurisdiction after the negatives had been destroyed as obsolete for military purposes or because space was needed for other purposes.

The various agencies concerned are at present working on this problem and have plans for a negative depository to handle all negatives accumulated as a result of the war, and perhaps all other negatives of permanent value that are property of the government. Details of this scheme are not complete, but the plan for the building is before Congress for approval. The main necessity is to gain congressional approval and appropriations to build the needed building and to provide the staff to catalog and administer the collection.

It is hoped and anticipated that if such a depository becomes an actuality the material will be generally available to scientists, regardless of their governmental or institutional connections.

This article is written for the purpose of stimulating those scientists and organizations of scientists whose interests and researches will be served by having available this great accumulation of photographs to indicate to the government agencies involved and to Congress their needs and concern as to its disposition. If this is neglected, the arrangements finally made may be disappointing and the greatest scientific good may not be served.

F. R. FOSBERG

THE TOXICITY OF DDT TO DAPHNIA

IN view of the widespread interest in the effect of DDT on animal life in general a series of experiments was carried out to determine the threshold concentration of toxicity to *Daphnia magna*. A suspension of DDT[1] in Lake Erie water was made by adding one ml of a one per cent. solution of DDT in acetone (one g DDT to 100 ml acetone) to 249 ml or more water for initial concentrations. The remainder of the procedure followed was the same as that described by the author in determining the toxicity of substances found in industrial wastes.[2]

It was found, in all but one instance, that 50 per cent. of the *Daphnia* were immobilized by concentrations of over one part per billion in thirty-two hours or less. Concentrations from one to one hundred parts per billion immobilized the animals in periods between sixteen and thirty-two hours. Animals in concentrations of less than one part per billion survived as long as the controls in Lake Erie water alone. Some experiments were run as long as 130 hours.

These results may be of significance in relation to using DDT for mosquito control, since in many localities it is essential that the zooplankton be protected.

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REPORTS

PROPOSALS FOR A NATIONAL RESEARCH FOUNDATION

THE joint meeting of the National Advisory Health Council and National Advisory Cancer Council of the Public Health Service, was convened on September 28, 1945, to consider specifically the relation of the Public Health Service to the report made by Dr. Vannevar Bush to the President, and to pending

[1] Dr. George L. McNew, of Naugatuck Chemical, kindly furnished an alcohol washed sample of DDT with a set point of 103.4.

[2] *Sewage Works Jour.*, 16: 1156–1165, 1944.

legislation pertaining to the implementation of the report.

Each member of the councils, at the request of Surgeon General Parran, expressed his opinion regarding the relationship of the Public Health Service with the proposed National Research Foundation or any overall research body which the pending bills would create.

The consensus of the councils may be summarized as follows:

I. The Bush report is a magnificent and distinguished document which outlines a plan for stimulating basic research in civilian research institutions and for continuing the close and profitable cooperation between civilian and governmental research agencies. To implement the recommendations of the report, the formation of a new body, the National Research Foundation, was proposed. The report expressed the belief that the existing governmental research agencies should be further developed and provided with more funds. It further emphasized that, although a new independent agency is needed to develop and foster research, this new agency should in no way conflict with existing governmental agencies, but should "supplement the research activities of these agencies in a valuable manner." The report proposes that a National Research Foundation would provide for the training of scientific personnel, promote basic research and cooperate with governmental research agencies. These aims and views expressed in the report were endorsed by the councils.

II. (*a*) The councils agreed that pending legislation is not clear regarding the relation of the proposed new body to the budgetary and research policies of existing governmental agencies. Although the various bills may be interpreted broadly as carrying out the intent of the Bush Report, the omission of specific language may permit the interpretation that the National Research Foundation would exercise direct or indirect control over the budgetary and research policies of the existing agencies. The Bush Report visualized only a consultative, advisory and cooperative relationship.

(*b*) In the firm belief that the Public Health Service should retain autonomy in its research activities, the councils were of the opinion that pending legislation should be clarified.

(*c*) Under existing law, (P.L. 410, Sec. 301, par. (c) and (d)), the Public Health Service has broad authority to coordinate and conduct research upon the physical and mental impairments and diseases of mankind, to allocate grants-in-aid for such research to other institutions, upon recommendation of its advisory councils, and to provide fellowships for the training of scientific personnel in these fields.

In this connection, the councils recommended that the Public Health Service continue to develop and expand its research and training programs, as authorized by Congress, both in its own facilities and through grants-in-aid to universities and other institutions.

III. A study of the pending legislation shows lack of agreement in regard to the representation of governmental agencies on the board or executive organization of the proposed National Research Foundation. In the medical portion of the Bush Report (Part II, p. 57) it is stated that "men who are experienced in research and who understand the problems of the investigator should administer the agency and its policies." The councils agree with the intent and implications of this statement, but they believe that governmental agencies should be represented on such boards and advisory committees as may be set up in or by the new body.

This opinion is based on the reasonable assumption that governmental agencies would appoint as their representatives men "who are experienced in research"; but it appears advisable that this requirement should be clearly expressed in the proposed legislation.

IV. In general, it was the opinion of the councils that appropriate legislation can maintain in peacetime the cooperative relationship which was maintained throughout the war among governmental agencies, the Office of Scientific Research and Development and civilian research institutions. In the establishment of a National Research Foundation, the councils favored the appointment of a board to carry out the powers and purposes of the foundation, and the choice by that board of its own chairman and other officers. The councils felt, however, that members of the board should be selected from among persons nominated to the President by the National Academy of Sciences and governmental research agencies.

It was the opinion of the councils that either (a) a new bill should be written as a cooperative enterprise of all governmental agencies concerned and the appropriate committee of the National Academy of Sciences; or (b) that the defects of proposed legislation be remedied by amendments such as those recommended by the Senate Committee on Naval Affairs in its reports on S.825 (Rept. No. 551, Calendar No. 549), July 28, 1945, as follows:

(1) The board shall in no way relieve governmental agencies of their responsibility for or authority over research and development work under their legal cognizance. This Act shall not be construed as superseding, curtailing or limiting any of the functions or activities of existing governmental agencies now authorized to engage in scientific research and devel-

opment, or as authorizing the board to exercise any supervisory direction or power of regulation over such functions or activities in any manner. Funds allocated by the board to other governmental agencies shall be utilized for projects designated by the board and undertaken on its behalf, and shall be in addition to, and not in lieu of, funds regularly appropriated to the agency concerned.

(2) Wherever practicable the board shall make use of the facilities and services of governmental agencies legally available for scientific research or development work, and wherever practicable it shall conduct research or development projects related to the legally authorized functions or activities of any governmental agency through or in cooperation with such agency. The said agencies are hereby authorized to make such facilities and services available to the Board and to participate in the conduct of its projects, on terms mutually agreeable to the Board and to the agency concerned. The board shall not operate laboratories under its own auspices.

V. To implement the foregoing opinions, the following motions were passed unanimously by the councils:

(1) That proposed legislation should be amended to include statements to the effect that autonomy in the development and conduct of their research programs should be maintained by those governmental agencies now engaged in such activities.

(2) That there should be governmental representation on such boards and advisory committees as may be set up in connection with the proposed National Research Foundation.

(3) That the joint report and recommendations of the councils be brought to the attention of other scientific groups, both public and private, now considering the proposals for a National Research Foundation.

SCIENTIFIC BOOKS

BIOLOGY

General Biology. By LESLIE A. KENOYER and HENRY N. GODDARD. 653 pp. Revised edition. Harper and Brothers. 1945. $4.50.

THE second edition of Kenoyer and Goddard's book joins the ranks of elementary biology text-books. Professor Kenoyer is head of the Department of Biology of the Western Michigan College and his interests are primarily in plant ecology. Professor Goddard retired from the same institution some years ago. His interests are in nature study and elementary science teaching.

The authors have attempted "(1) to introduce much material illustrative of the outstanding biological principles; (2) to place a satisfactory emphasis on both the animal and the plant kingdoms; (3) to steer a median course between the type study method and the method that emphasizes principles; and (4) to introduce wherever possible biological facts of general interest and practical or economic importance."

Chapters 1 and 2 deal with the scope and history of biology and include a brief survey of the plant and animal kingdoms. The next chapter is concerned with structure and function in the seed plants. This consideration of the seed plant as a typical organism is followed by chapters on cellular structure and the nature of protoplasm. Discussion of the latter topic consists primarily of elementary inorganic chemistry. Chapters 6 and 7 discuss food and digestion and metabolism. The process of digestion is treated with such brevity that it nearly missed inclusion in the book. The chapter on "metabolism" emphasizes diffusion, osmosis and photosynthesis.

Following these seven introductory chapters, fourteen chapters are devoted to the lower plants and to the animal kingdom. The usual organisms included in an elementary course are described. The description of individual organisms is brief, but an attempt is made to indicate their importance to more general problems. Thus, in the discussion of Amoeba we find a paragraph, on the role of the nucleus in the cell, based on experiments performed on that animal. In the chapter on bacteria we find mention of viruses, the electron microscope, spontaneous generation, carbon and nitrogen cycles, the sulfonamides and penicillin. A single chapter is devoted to chordate morphology and physiology. The frog is taken as a type and the emphasis is morphological. A chapter on the classes of vertebrates concludes the survey of the animal kingdom.

Genetics and embryology are covered in few pages but with an attempt to include as many aspects of these fields as is possible. The remaining plant groups (Bryophytes, Pteridophytes and Spermatophytes) are treated next, and then the authors turn to more general topics such as evolution, man's place in nature, ecology and conservation.

This résumé will give an indication of the material covered by the authors. Nearly everything that could conceivably be studied in any elementary biology course is mentioned. This extensive coverage of topics, which apparently is a trend in current biology text-books, is probably made with the hope of increasing adoptions. In the present instance this results in more superficiality than broadness of view. This, in the reviewer's opinion, is the chief weakness

of the book. To give an example, in the chapter on evolution, which occupies twenty-nine pages, the following topics are considered: meaning of the term evolution, morphological resemblances among animals, homologous organs, analogous organs, vestigial organs, physiological resemblances among organisms, chemical resemblances, use of precipitins in determining relationship, similar parasites on similar hosts, embryological resemblances, fossils, methods of determining geological time, the eras of geological time, the formative era of the earth, life in the Archeozoic, Proterozoic, Paleozoic, Mesozoic and Cenozoic times, geographical distribution of organisms, Lamarck and the inheritance of acquired characters, Darwin and natural selection, artificial selection, types of genic and chromosomal mutations, the role of mutation in species formation, role of isolation in speciation, induction of mutations with radiations, a summary of the factors in evolution, the origin of living matter, the organization of living matter into cells, the direction of evolution and the place of evolution in modern thought. With reference to the latter it is asserted that the concept of evolution and the law of gravitation are "probably the loftiest conceptions of which the human mind is capable."

The treatment of physiology seems wholly inadequate for a biology course given to-day. The use of a seed plant to introduce organisms might be questioned. With this as a basis it seems doubtful that the full value of the chapters following, which discuss digestion and metabolism, would be gained.

The illustrations are excellent.

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FLORA OF ILLINOIS

Flora of Illinois, containing keys for the identification of the following plants and ferns. By GEORGE NEVILLE JONES. 317 pp. 2 maps. Notre Dame, Ind.: (Am. Midl. Nat. Monogr. No. 2). 1945. $4.00.

THIS book, second of a series edited by Theodor Just, is an annotated key to the higher plants of Illinois. We may hope it is the precursor of a detailed manual such as that for Indiana by C. C. Deam. Meanwhile, it is a most useful working guide to plants of a state which has never had a plant list both comprehensive and generally accessible. The present enumeration comprises 2,124 species in 716 genera and 152 families.

The introduction includes a description of flora and vegetation, with short lists of plants characteristic of the eight geographic divisions recognized. Boundaries of these divisions are superposed on the map showing forest and prairie (the former shaded), prepared by C. J. Telford in 1926. The second map locates and identifies counties. Pages 8–31 are occupied by the keys to families, arranged according to growth-form in 19 sections. The body of the book (to p. 272) is the annotated key to genera and species. A ten-page glossary, a selected bibliography of 51 titles on botany of Illinois, a detailed bibliography of over 400 taxonomic monographs and revisions of particular families and genera, an author index to these works and an index of plant names complete the book.

In addition to the taxonomic characters, items of information of other kinds are inserted in the key. These items include for every species its distribution and its habitats in Illinois; there is usually also some statement of its degree of abundance. Synonyms are given where they may be useful to non-systematist users of the book, *e.g.*, for a species long known under a recently rejected name. Common names are given for those species that really have them. The months of flowering are given for most plants; and for any species not native, its source. For those rare species whose present or past occurrence in Illinois could be questioned, locality and collector of one or more authentic specimens are cited, often with year or collection number. This plan of inserting other information in the key itself makes possible a compact arrangement which keeps down the size of the book. As a possibly extreme example, the family *Lobeliaceae* is treated in three inches of type: 7 species in 1 genus in less than half a page.

The reviewer is not qualified to pronounce upon accuracy of taxonomic judgments made nor validity of names used. He has some reason to believe that in these respects the work is of the same high quality that marks the rest of it, and that the keys are workable.

The extreme brevity of treatment is attained at a cost: many of the annotations are not sufficiently explicit or definite. This lack seems most serious in designating habitats. To illustrate, habitat notes are quoted for a few particular species, followed in each instance by a substitute note as it might appear in a revised edition. *Bouteloua curtipendula,* "prairie soil"—hill prairies and sandstone cliff-tops; *Populus grandidentata,* "river banks"—forested bluffs and ravine-slopes; *Psoralea tenuiflora,* "dry soil"—dry western prairies, especially of loess bluffs; *Taenidia integerrima,* "woods and thickets"—uually eroding clay bluffs or bare soil. Some of the habitat designations may be expanded by inference; thus "roadsides" may be taken to mean surviving remnants of less-disturbed vegetation: prairie or herbaceous

ground-cover of open forest lands. But it may instead mean weedy vegetation of trampled roadsides, as it does with *Aristida dichotoma*. Field experience usually enables the user to decide which meaning to read into a statement.

Very few species known to occur in Illinois have failed to be included. Dr. Jones's criterion for admission was his own examination of a valid specimen. In a nearly complete scrutiny, the reviewer found only 4 or 5 typographical errors or inadvertent slips, none of which is likely to mislead; possibly worth mentioning—on page 203, *Dodecatheon amethystinum*, for "Mo." read *Iowa*.

Numerous distributional problems remain to be solved, and additional species to be found, even in so thoroughly cultivated an area as Illinois. Such notes as "woods, local" for witch-hazel and for twinleaf (*Jeffersonia*), raise questions: are they restricted to few stations because of an undiscovered environmental requirement; are there unknown hazards in dispersal or establishment; or are they limited in their abilities to compete? When two entities are recognized where formerly one served, as in the trifoliolate sumacs, *Rhus aromatica* Ait. and *R. arenaria* (Greene) G. N. Jones, one asks whether it is only the latter that forms thickets over the extensive dune areas of the larger valleys or both species. Such problems may be solved by further field study; the new Flora should stimulate interest and activity in them.

A most appropriate feature of the book is the already-mentioned citation of collectors of rare or little-known species. The old-time collectors, too little known to present-day botanists, did much to preserve data now unobtainable. The earliest record noted is 1829, when S. B. Mead collected *Ceratophyllum echinatum*. Mead was perhaps the earliest resident collector. He prepared the first general list for the state, now practically unknown.

S. B. Mead. ***Catalogue of plants growing spontaneously in the state of Illinois, the principal part near Augusta, Hancock County.*** The Prairie Farmer, 6: 35–36, 60, 93, 119–122. 1846.—A manuscript version of this list was prepared in 1942 by Dorothy May Croker (Mrs. Frank Newton Gillette), and may be consulted at the Natural History Library, University of Illinois. Its title: ***Mead's 1846 Illinois flora, with present-day names.*** In it Mead's notes on locality and habitat are more conveniently arranged. The number of species is 895.

It is presumed that Mead's list, rather casually mentioned in I. A. Lapham's catalogue of Illinois plants (1857) was a major basis for it. Other early collectors were C. A. Geyer, M. S. Bebb, Elihu Hall, John Wolf, George Engelmann, Frederick Brendel, Jacob Schneck, T. J. Burrill, George Vasey, H. H. Babcock and G. H. French. Somewhat later were W. K. Higley, E. J. Hill, H. N. Patterson, W. E. Andrews, Robert Ridgway, H. Shearer, G. P. Clinton, A. B. Seymour, M. B. Waite, W. S. Moffatt, W. A. Nason, F. E. McDonald, L. M. Umbach and H. S. Pepoon. To mention living botanists, the collections of Agnes Chase, V. H. Chase, Gleason, Gates, George D. Fuller and E. J. Palmer are important. G. N. Jones has collected extensively within the past few years. In this work, as in herbarium studies and preparation of manuscript, he has had the able assistance of Florence Freeman Jones.

Botanists of Illinois and elsewhere have waited long for some one with the energy and ability of Dr. Jones to prepare a usable and modern guide to the flora of the state. Progress in systematic and other phases of botany will be accelerated by it.

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MINERALS

Minerals of Might. By WILLIAM O. HOTCHKISS. vii + 206 pp. 14 graphs and maps. Lancaster, Pa.: The Jaques Cattell Press. 1945. $2.50.

"I AM afraid the nations of the world have neither the intelligence nor the character to postpone forever World War III." So states Mr. Lawyer, a fictitious character in "Minerals of Might," a thought-stimulating book by William O. Hotchkiss, president emeritus of Rensselaer Polytechnic Institute. That is a stern indictment of the peoples of the world but one which seems justified after an unemotional analysis of recent world news.

"Minerals of Might" is a book which every American citizen should read even if he has to forego his daily game of bridge to do it. There is information in it which should cause him to ponder well before he casts his next votes for those who will formulate and execute our foreign and domestic policies. The book explains clearly the differences between the "have" and the "have not" nations and sheds considerable light on the economic pressures which lead to war, cleverly concealed as they are under ideological cloaks. It shows, too, that rich as America is, she is not self-sufficient in many of the minerals most necessary to our welfare, happiness and defense. The statement "Of most of our resources we have used more in the last thirty years than we had used before in all history—more in 30 years than in the preceding 30 centuries" may be prophetic of future accelerated use.

Although the book contains a great many statistics it is not stuffy. The data are given in such a way that reading is easy and the few charts shown may be omitted if the reader so desires. It is evident from the treatment that Dr. Hotchkiss is an educator. He

does not deal with his subject as something set apart from reality as many scientists do. Rather, he integrates it with our everyday lives and the lives of our children. Moreover, he gives enough of the historical and social background of the many minerals discussed to enable the casual reader to enhance his education. Incidentally, there is a quotation from John Stuart Mill on page 42 which should be required reading for every one of us.

The role which minerals play in the national defense is explained and the rate at which war depletes the reserves of exhaustible critical minerals is emphasized. We now have enough evidence to predict that war of the future will differ markedly from war of the past, both in materiel and personnel. The differences will be felt in our mineral reserves. Unfortunately it appears that the greatest load may be thrown upon the items least able to bear it, such as mica, chromium, cobalt, molybdenum and tungsten. The farther advanced our technology becomes the more we will come to depend on the rare and unusual materials.

Starting with iron ore, Dr. Hotchkiss discusses world production, use and probable reserves of the major metals: copper, lead, zinc, aluminum, tin, manganese and many of the minor metals and minerals. In each discussion he emphasizes the part which the mineral plays in maintaining our mechanized civilization and he tells us something of the effort required to win the metal from its earthy prison. I wonder if all of us truly appreciate the fact that to secure one ton of iron we must dig two tons of ore; or to secure one ton of copper we must dig 83 tons of ore! And the quality of our reserves is diminishing.

Special emphasis is placed upon depletion of high quality iron ore reserves, but Dr. Hotchkiss believes that research will solve most of the beneficiation problems and that the Lake Superior region will be our major source of supply for many years to come. Contrasted with statements relative to research making available presently non-commercial mineral bodies is the statement that magnesium is the only metal available in inexhaustible quantities. Apparently it awaits a Mushet and a Bessemer.

Water is little thought of as a major mineral resource, yet without adequate quantities of it industry as well as agriculture would suffer severe restrictions. Dr. Hotchkiss discusses water as a mineral resource in the production of power. While that use of it is admittedly of high importance other industrial uses are, too; and those he fails to mention even though it is known that the retreat of ground water supplies is giving concern to the geologists of at least two eastern industrial states.

Oil, coal and natural gas are the principal sources of energy available to us in sufficiently large quantities at prices which we can afford to pay. Dr. Hotchkiss's discussion of oil and coal while brief is sufficient to give the layman about all he needs to know to read his newspaper more intelligently and to help him understand the world negotiations now under way. The fact that coal resources in the United States are adequate for thousands of years coupled with the advances made in the chemistry of coal promises a bright future for many industries. Supplementing the discussion of coal resources Dr. Hotchkiss points out that improvements in efficiency in the use of coal are to be expected, which if consummated will extend our reserves several-fold. His discussion of energy sources is completed with factual references to the possible use of solar energy and wind power. It is interesting to note that he was as unconscious of the development of atomic energy as most of the rest of us.

Mineral resources are so important to the life of all nations that a separate section was devoted to them in the Atlantic Charter. Dr. Hotchkiss's discussion of the limitations of the language of that section are well thought out and the opinions he advances are worthy of more extended study. He also discusses the stockpiling of strategic and critical materials toward a time when they may be needed to help defend us against an enemy now unknown. His recommendation is that we stockpile material from our own reserves in order to assist in balancing employment in slack times. This reviewer is of the school which believes we should purchase material for stockpiling from abroad and leave our own reserves intact for the better development of our future—the point is controversial.

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